Mr DESARGVES. vniversall Way of makeing all manner of Sun dialls. Published by Daniell King. & Sold by Isaake Pridmore at ye golden falcon in ye Strand. Ao 1659.

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Mr. *De* SAKGVES

UNIVERSAL WAY OF DYALING.

OR

Plain and easie directions for placing the Axeltree, and marking the hours in Sun-dyals, after the *French*, *Italian*, *Babylonian* and *Jewish* manner.

Together with the manner of drawing the lines of the signs, of finding out the height of the Sun above the Horizon, and the East-rising of the same, the Elevation of the Pole, and the position of the Meridian.

All which may be done in any superficies whatsoever, and in what situation soever it be, without any skill at all in Astronomy.

By DANIEL KING Gent.

LONDON,
Printed by *Tho. Leach* and are to be sold by *Isaac Pridmore* at the *Golden Faulcon* in the *Strand*, near the *New Exchange*, 1659.

UNIVERSAL WAY
OF
DYALING.

2244:11

TO THE
ILLVSTRIOVS
GEORGE VILLIERS,

Duke, and Marqueſs of *Buckingham*, Earl of *Coventry*, Viſcount *Villiers*, Baron *Whaddon*, and *Ras*, Knight of the moſt noble Order of the *Garter*, &c.

Sir,

HAving had the honour to obſerve your Graces great affection, and love to Sciences and Arts, and your own excellency being moſt eminent therein, together with your unparallel'd love and inclination to the ſplendour of your Native Country, in promoting Learning and Ingenuity. Theſe high merits with my own par-

ticular obligations and attendance, encourage my endeavours of the patronage to a new birth never presented to the English Nation; presuming by Gods assistance to bring forth something of worth that hath not yet seen light, and if your Grace shall please to pardon my observant presumption, you will hereby more strictly engage him ever to honour your Heroick worth, who is,

The very humblest of
your Servants,
Daniel King.

The Preface.

Concerning the particulars of this TREATISE.

WHereas the Superficies or outsides whereon Dyals may be made, may be either flat, bowed, or crooked, plain or rugged, & situated diversly, the most part of the books treating of this matter, contain severally the manner of making flat Dyals in all kinds of positions, Horizontal, Vertical, Meridional, Septentrional, Oriental, Occidental; Declining, Inclining; Inclining, and Declining; and accordingly in all other kinds of superficies.

They may also shew, for those that are ignorant of it, the way to find the elevation of the Pole, the Meridian line, the Declinings, Inclinings, and other particularities.

But Monsieur *de Sargues* intention being to publish nothing, if it be possible, that is to be found in another Book, and to give you only the general Rule to make, and not to copy out a number of examples all differing one from another; I will give you but one example only in this volume, by this universal manner, the discourse

whereof may be applyed generally to all kinds of ſuperficies, and in what ſituation ſoever they be, without having any knowledge of the Pole, nor of the height of the Sun, nor of the declining or inclining, nor of the Meridian line, nor of any other thing in Aſtronomy, and without a needle touch'd, nor of any kind of thing that may give a beginning to that, as you ſhall ſee yet better when we ſhall treat of the practice.

And in practiſing this general Rule, you ſhall find at one and the ſame time, the elevation of the Pole, and the poſition of the Meridian, you ſhall know how to place the needle of your Dyal, and ſo you ſhall come to find the equal hours, which are called hours after the *French* way, *alias* Aſtronomical.

The reſt being more curious than neceſſary, I thought to ſet down nothing elſe but thoſe two things; But I have been perſwaded, for the ſatisfaction of ſome, to add alſo the manner of drawing upon the ſame ſuperficies, the lines of the ſigns, the hours after the *Italian* and *Babylonian* way, and of the Antients, the height of the Sun, and the ſituation thereof, in reſpect of the Horizon.

Of the Practice of Sun-Dyals.

MAny diverſe things are repreſented in Sun-Dyals by the ſhadow of the Sun, to divers ends, the hour is ſhewn by them, and ſerves only

ly for that purpoſe every day. Other things are repreſented alſo by it, as the ſigns, and other particularities, whereby it may ſerve ſometime for the divertiſement of a few

In antient time the hours were not counted as they are now a dayes, and in *Italy* at this day they are counted otherwiſe than in *France*

The manner that they count their hours in *France* is according to Aſtronomy, and here is at length a generall way of framing and making Dyals with houres equal to the Sun, according as the hours are now counted in *France*, after which way one may come to ſhew if need be, by the ſhadow of the Sun, and alſo of the Moon, whatſoever can be ſhewn concerning other circumſtances to ſatisfie curioſity.

There are two things which together do compoſe thoſe kinds of Dyals of equal hours, after the *French* way, the one is a piece that ſhoots out or ſallies out of the ſuperficies of the Dyal, the ſhadow whereof falling upon this ſuperficies, ſhews what a clock it is, the other are the lines drawn upon the ſuperficies of the Dyal, each of them repreſenting one of the hours after the *French* way.

They make Dyals after the *French* way wherein there is only the ſhadow of one portion alone, as might be a button of the piece that ſhoots out, that ſhews what a Clock it is. But in this generall way, there is ſtill the whole ſhadow of all the length, in a direct line of this piece that ſhoots out, ſhewing continually what a Clock it is, of

which piece or length, you may take if you will a button, and mark the hours with that button only, together with all the other particularities that may be added to such Dyals. Some call by one and the same name these two kinds of pieces the shadow whereof shews the hour, as well that same whose shadow shews continually the hour at length, as that which hath but the shadow of a button to shew it.

But to the end we may distinguish both kinds of pieces one from the other, that same whose shadow shews the hour at length, and is the original spring of all the others, I call it the axeltree of the Dyal.

This axeltree may be made as well with a straight, round, and smooth rod of yron or brasse, as with a flat piece, and cut of one side in a straight line.

There are often other rods in the Dyals, which serve to bear up the axeltree that shoots out, and those kind of rods I call the supporters of the axeltree.

The lines that are drawn upon the superficies of the Dyal, and that shew each of them one of the hours after the French way, I call them lines of the hours after the French way.

In the innumerable number of such kinds of Dyals as may be made after the French way, it happens that the superficies of the Dyal, is either all flat, or is not so altogether.

When the superficies of the Dyal is all flat, every line of the hours is a straight line.

And

And when the ſuperficies of the Dyal is not altogether flat, it may be that every line of hours is not all ſtraight alſo.

To make one of thoſe Dyals of equal hours after the French way, by this univerſal way, there are two things to be done one after another. The firſt is to place the axeltree as it ought to be, that is, ſhooting out of the ſuperficies of the Dyal; The ſecond is, to draw the lines of the hours as they muſt be upon the ſame ſuperficies.

And by means of this general way, you ſhall do thoſe two things without knowing in what day, nor in what time of the year, nor in what Country you are, without knowing what the ſuperficies of the Dyal is, whether it is plain or rough, nor which way it looks, without knowing any thing concerning the making and the placing of the parts of the world, or without any skill in Aſtronomy, without any needle touch'd with the loadſtone, or any inſtrument or figure that may ſerve for a beginning towards the making of a Dyal: But by the means only of the Beams of the Sun, by one general rule you ſhall place the axeltree, and draw the lines of thoſe hours upon one of thoſe Dyals whatſoever the ſuperficies may be, and which way ſoever it looks, with all the celerity and exactneſſe that is poſsible in art; and if you are equally exact in every operation, you ſhall make by this means many Dyals upon different ſuperficies, and turned towards ſeveral parts of the world, which ſhall agree plainly among themſelves, and if you do not do it, you may be

ſure

ſure that the fault is on your part, and not in the rules, ſince that others do ſucceed well in it.

There are ſome pieces that are requiſite for the framing of a Dyal, and whereof it is compoſed, ſuch are the axel-tree rod with its ſupporters.

There are other pieces that muſt be uſed in the making of a Dyal, as Rules, Compaſſes, a Squire, a lead with his two frames, one to mark with, and the other to level.

There are ſome other things that you ſhall uſe alſo, as pegs, and rods, either of yron, or of braſſe, or of wood, ſome ſharp at both ends, the others ſharp at one end only, a table, either of wood, or of ſlate, or of any other ſtuff, flat and ſolid, to draw upon if need be, ſome ſtraight lines with the rule; and in caſe the ſuperficies of the Dyal were plain and even, you muſt uſe ſome fine ſtrings, ſupple and ſtrong, ſome maſtick, cement, or plaſter, or ſuch like ſtuff fit to ſeal with, *&c.* all which things you muſt have in readineſſe, whenſoever you will go about the making of a Dyal.

And though you would learn to make but one of theſe Dyals well, it is fit you ſhould have ſome models of all thoſe pieces, and when you are upon thoſe chapters that concern them, as you ſhall underſtand an Article, it will be requiſite that with the models of thoſe pieces, you work at the ſame time an actual model of the thing which that article ſhall teach you to do, and ſo you muſt work from one end to another, till you have at laſt every way compleated an actual model of this

this kind of Dyals, and you ſhall need to make but few of ſuch models of Dyals upon any ſuperficies, turned towards ſeveral parts of the world, to bring you acquainted with the practice of making Dyals to the life, or after the natural, in what kind or odd ſituation of ſuperficies ſoever they may be.

Laſtly, you ſhall find the precepts and the deſcriptions to be more troubleſome, than the actual making or working, ſtudy only to be as exact in every one of theſe operations of making of theſe Dyals, as in the practice of other Arts.

The

The Epistle to the

READER.

Courteous Reader,

THis Treatise being originally written in French, and generally approved of all those that have any skill in the Art of Dyalling, I have thought it my duty to lay hold upon this occasion, to shew how desirous I have ever been to procure any good unto my Country. Therefore I have caused it to be carefully translated into English, and have set it forth for the good and utility of all such, as are curious, and true lovers of that Art; Reputing my self most happy to meet with any occasion, whereby I may contribute any thing towards the advancement of learning, and of the publick good, —Non enim nobis solum nati sumus; *We are not meant to be wholely and sely for our selves.* As for the work it self, I am so confident it will so gain the attentive Readers approbation, as that I shall forbear to say any more in commendation of it, than that it is an expedite, and sure way of obtaining the site of the Axis, and of other requisites in the framing of all sorts of Dyals, of no lesse curiosity, than use, performed without the ordinary rules and presuppolals of the

the spiritual calculations and practice; I need premise no more, but advise to follow the directions that are set down through all the book, for effecting that which is promised, and thou shalt see the same plainly and readily performed. Accept then, Courteous Reader, this small labour, the undoubted Testimony of my Love, as kindly as I offer it cordially unto thee, hoping that God will enable me to give thee hereafter some thing of more consequence,

So Farewell.

Viere & fruere.

Thine D. K.

To all Lovers *of Ingenious Practices.*

THe *French* have excelled all other Nations in the Art of *Perſpective* for this laſt Age, their many Books and curious Writings ſo excellently compoſed do witneſſe for them.

Dyalling I accompt one kind of Perſpective, for that glorious Body the *Sun*, the Eye of the world, traceth out the lines and hour-points by his Diurnal Courſe, and upon the reſubjected *Plane* by the laws of Picture, *Scenographically* delineates the Dyal.

Many have writ upon this ſubject of ſeveral Countryes, in ſeveral Ages, many are the Rules and Practices ſet down; But among all thoſe of forein Parts, none hath performed the ſame with more eaſe, and leſſe trouble, than *Monſieur du Sargues* the Author; as wholy laying aſide thoſe tedious obſervations of Azimuth's, Declination, Reclination, Inclination, Meridian; Subſtile, *&c.* and performing the operation only by three obſervations of the Suns ſhadow from a Point.

It will not be amiſſe to give the Reader a ſmall conſideration hereof; the point B of the pin A B, in all the figures is alwayes one part of the Axis,

or

or *Gnomon* of the *Dyal*, and may be uſed to ſhew the hour: this point B, you muſt imagine to be the Center of the Earth (for the vaſt diſtance to the Sun, maketh the ſpace betwixt the Center and ſuperficies of the Earth to be inſenſible) and from it at all times of the year (excepting the Æquinoctial day) the Sun in its courſe forms two Cones, whoſe Apex is the point B, that next the Sun termed *Conus luminoſus* or the light Cone, the other whereof our Author makes uſe, termed *Conus umbroſus* the dark Cone, now in this dark Cone, if by any three points equally diſtant from the Apex B, the Cone be cut, the Section will be a Circle parallel to the *Equinoctial*: And thereby, as the Author ſhews many wayes, the poſition of the Axis or Gnomon may be found out, and the Dyal eaſily made.

Now it reſts, courteous Countryman, that we be very gratefull, and every way forward to encourage Mr. *D. King*, one very induſtrious in the ſtudies of Antiquities and Heraldry; who out of his deſire to ſerve his Country, hath cauſed this piece ſpeak Engliſh, hath been very carefull to ſee the Cutts well done, and will (no doubt) proceed to cauſe ſome of thoſe rare pieces of perſpective in French to be tranſlated.

Then proſper King, *untill thy worthy hand,*
The Gallick *learning make us underſtand.*

JONAS MOORE

Matheſios Profeſſor.

Books

Books Printed for *Isaac Pridmore*, and are to be sold at the Golden Faulcon near the *New-Exchange*.

THE Rogue, or the life of Gusman de Alpherache the witty Spaniard, written in Spanish by Matthew Aleman, Servant to his Catholick Majesty; the fifth and last Edition Corrected.

A Physical discourse, exhibiting the cure of Diseases by signatures, wherunto is annexed a Philosophical discourse, vindicating the Souls prerogative in discerning the truths of Christian Religion with the eye of reason, by R. Bunworth.

Self-Examination or Self-Preparation for the worthy receiving of the Lords Supper; delivered in a Sermon concerning the Sacrament, by Daniel Cawdrey, sometimes Preacher there, with a short Catechism: the third Edition.

The Obstinate Lady, a Comedy written by Sir Aston Cockaine.

Spertive Elegies written by Samuel Holland Gent.

A New discovery of the Present Disease, and running of the Reins, with plain and easie directions for the perfect curing the same, by R. Bunworth.

The Vaspotted high Court of Justice, erected and discovered in three Sermons Preached in London and other places, by Thomas Baker, Rector of St. Mary the More in Oxon.

A Chain of Golden poems, imbellished with wit, Mirth, and Eloquence, together with two most exelent Comedies, viz. the Obstinate Lady, and Trapolin supposed a Prince, by Sir Aston Cockaine.

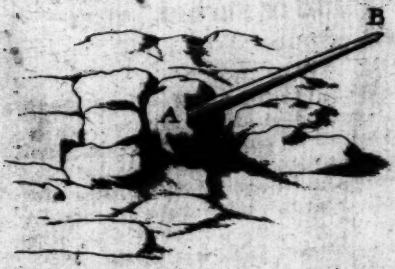
The Assent to Bliss by three steps, viz. Philosophy, History, and Theology, in a brief discourse of Mans felicity, with many remarkable examples of divers Kings and Princes.

The Heroical Lovers, or Antheon & Fidelia a poem, by Thomas Bancroft.

Advice to Balaams Asse, or Momus Catechised, in Answer to a certain scurrulous and abusive scribler by, John Heydon Author of advice to a daughter, by T. P. Gent.

The Analysis of all the Epistles of the new Testament, wherein the chief things of every particular chapter are reduced to heads, for the help of the Memory, and many hard places explained, for the help of the understanding, by John Dale Master of Arts, and fellow of Magdalen College in Oxford.

Extra-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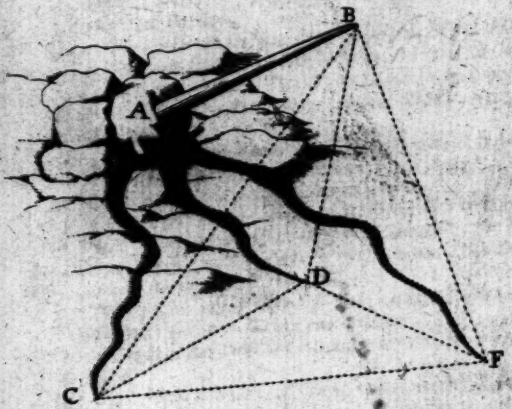
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I Figure,

To all ſorts of People.

I come now to the firſt of thoſe two things that you are to doe for to make one of thoſe Dyals, which is the manner how to find the poſition, or the placing of the Axeltree.

WHen you have a mind to find out the right placing of the Axeltree of one of thoſe Dyals by this general way, mark firſt which way the light of the Sun comes to the place where you will make your Dyal, and which way it goes out again.

Then make faſt upon the place, as the figure above doth ſhew, with cement, plaiſter, maſtick, or the like, a peg or pin, A B, by the great end A, putting the other ſmall or ſharp end B as far out of the ſuperficies of that place as you can, In ſuch ſort that while the Sun doth ſhine upon that place, the ſhadow of the end of the pin B may fall always upon this ſuperficies, and for the reſt it is no matter how this pin or peg be framed, or placed, or turned, you are only to look to the ſmall end thereof, that muſt be in ſuch a manner, that you may ſet or apply upon it one of the feet of the Compaſs.

Then in a fair Sunſhiny day, when the light is very clear, and the ſhadow very clean, whilſt it falls upon this ſuperficies in the figure below, mark in it, as the figure ſhews, In

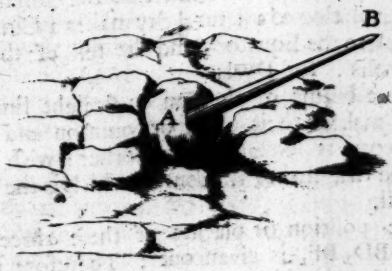
one and the ſame day, at three ſeveral times as far aſunder as you can, three ſeverall points C D P, each of them at the end of the ſhadow of the pin A B that anſwers to the ſmall end of it B.

You muſt note that there is a certain time and place in which you cannot mark the points of the ſhadow; That is when this ſuperficies is flat, and ſituated after ſuch a manner, that the ground plot thereof being ſtretch'd at length, anſwereth and teacheth into the center of the Sun.

For in that caſe how ſhort ſoever the peg or pin B may be, the ſhadow hereof cannot goe and fall in this ſuperficies, but at the end of an extréme length.

Therefore when the days are equal with the nights, or very near, you cannot mark in this manner three points of ſhadow in a flat ſuperficies, which is ſituated in that manner called parallel to the Equator.

When you have thus mark'd three points of ſhadow, you have no more need of the light of the Sun, and you may make an end of the reſt in any other time and ſeaſon, as well by night as by day, as I ſhall ſay three times together for one and the ſame manner, in three ſeveral ways to be expreſſed, after I have briefly ſatisfied the Theoriciens that take pleaſure to ſee the reaſons of the precepts, or rules of the practice of the Arts, before they ſee the precepts themſelves.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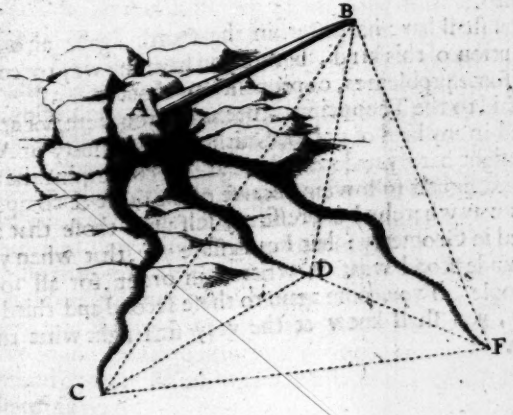
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To the Theoriciens.

This Reſolution will ſerve you.

AFter you have conceived that the Sun in his full revolution of a natural day makes a Circle parallel to the Equator, and the reſt of this Hypotheſis, for Dyals.

The three beams of the Sun or ſtraight lines, BC, BD, BF, make in their point or common end B. ſome angles or corners equal one to another; with an other ſtraight one that makes the fourth, which is the Axeltree of the Dyall.

Now the poſition or placing of theſe three ſtraight lines BC, BD, BF, is given out; Therefore the placing of this fourth which is the Axeltree of the Dyal is given alſo.

You ſhall have hereafter in the fourth figure an other reſolution of this kind, before you have the way to compoſe ſome problemes, or propoſitions about it.

I ſaid to the Theoriciens, becauſe if you were not at all verſed in any kind of practice, either of Geometry or Art, you might hardly underſtand me at firſt concerning the 2d. & third figures following, becauſe of the ſhort & compendious way whereby I expreſſe my ſelf unto thoſe that are skilled in Geometry: but I can aſſure you, that when you have underſtood what is written in order for all ſorts of people, if you come again to theſe ſecond and third figures, you ſhall know at the very firſt ſight what they mean.

For

For the Theoriciens,

And for those that are skilled in Geometry.

THe I figure is a plate of some thin, flat, smooth, and solid stuff, as Iron tinned, or the like, being round, and having a hole just in the Center, greater or lesser, according to the occasion.

The II figure is a straight rod, round, smooth, and solid, as of Iron, or the like, of the bigness of the hole in the plate.

The III figure is as it were a whirl made of the plate, and of the rod put thorow the plate, in such sort that it is perpendicular to the said plate, as the squire that turns round about doth represent unto you, and is so fast that it cannot stir or move.

In the V figure A B is the peg or pin that hath mark'd unto you the points of the shadow C D F, the rods or sticks B C, B D, B F, are solid and strong, as of wood, or the like, having each of them a slope edge in a direct line all along, going from the point of the peg B to each point of the shadow C D F, and are so turned or ordered, that in applying the whirl unto them, the edge of the plate may goe and touch the three slope edges of the rods all at once; and the rods or sticks are made fast in this situation, in such sort that they cannot move nor stir.

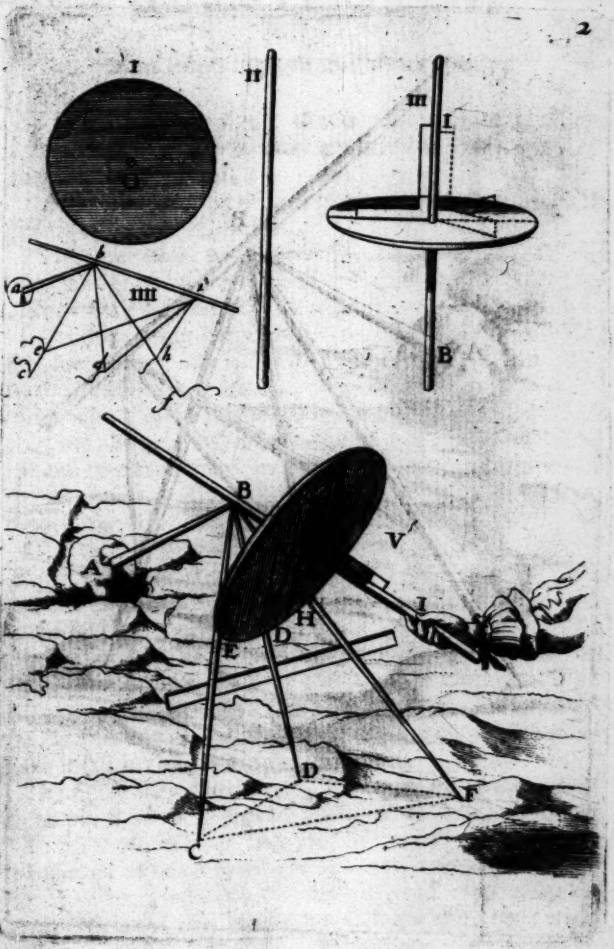
The rule that crosseth over the three slope edges, B C, B D, B F, toucheth them all three, or else two at the time only, whereby it shews whether those slope edges are all three in one and the same situation, or upon one and the same ground or no, and on which side is their hollowness when there is any.

The hand applies the whirl unto it, and keeps it there till the Axeltree B O I come to touch the end of the peg or pin B, and that at the same time the edge of the plate E D H touch the three slope edges of the rods.

And when the whirl is placed or setled after this manner,

ner, the rod is the Axeltree of the Dyal, and placed as it ought to be, and there remains nothing else but to make it fast in this situation or position.

The IV. figure doth shew, that if you goe to make use of thin and supple strings in this practice or working, in pulling those two mark'd with I e, and I h, to make them fast in direct lines, they would make the two strings mark'd with b c, b f to bend, so that you can doe nothing exactly with them, which is the reason that *Monsieur Desargues* hath not thought fit to make use of them for the Beams of the Sun, but rather of the slope edges of the rods that are both stiff and strong.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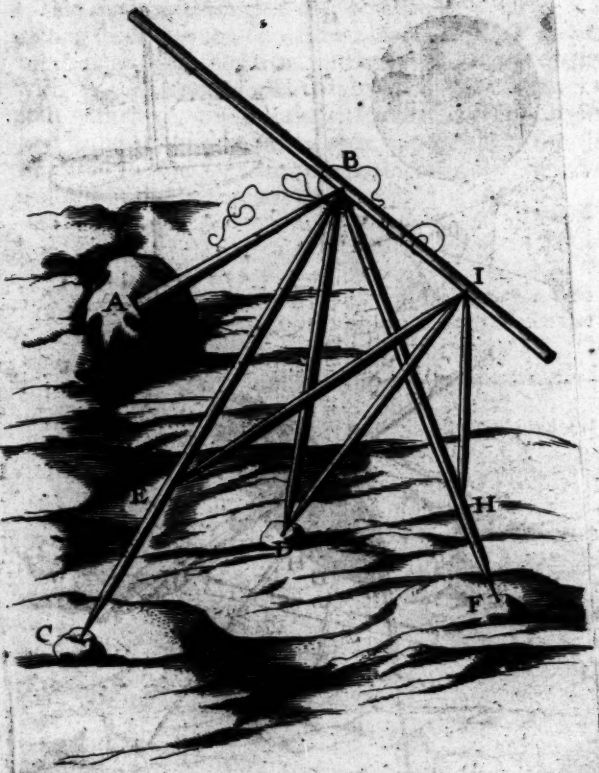
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To the Theoriciens,

And others that are skill'd in Geometry.

THis foregoing figure ſhews to the eye that all the pieces of the Inſtrument are made ſo ſtrong and firm, that they cannot bend.

A B is the pin, by whoſe point B, you have had the points of ſhadow C, D, F.

The three ſticks or rods BC, BD, BF, have each of them a ſlope edge in a direct line at length, going from the point of the pin B to the three points of ſhadow, C, D, F.

The ſlope edges of the two longeſt ſticks or rods, BC, BF, have ſome portions made in them, equal every one to the third and ſhorteſt ſtick B D.

The three ſticks IH, ID, IE, are every one longer than BD, and all three made even, then they are joyned all by the end to one of the points EDH, of the ſlope edges of the other ſticks, BC, BD, BF, and their other ends I, are brought together in one and the ſame point, I.

The rod BI, is ſtraight, round, ſmooth and ſtrong as of yron or the like, it hath a ſtraight line B I, drawn from one end to an other, and one of the points B, of this line of the ſaid rod toucheth the point of the pin; And with an other point I of the ſame it toucheth the point I of the three rods or ſticks.

This being ſo, the rod BI comes to be the Axeltree of the Dyal rightly placed, there remains nothing elſe but to make it faſt in this poſition or ſituation.

The figure ſhews in the rods that goe from the point of the pin B, to the points of ſhadow C D E, how one may make faſt thoſe rods at one end to the pin, and alſo all together to one point, by binding them to it; And how they may be made faſt at the other end to one point of the ſuperficies of the Dyal, by faſtning them to it with maſtick, plaſter, cement, or the like.

This way is more ſure than that with the ſtrings; But

yet it is not the easiest, nor the least troublesome, in my judgement.

To the Theoriciens.

Another resolution of the same kind with the former.

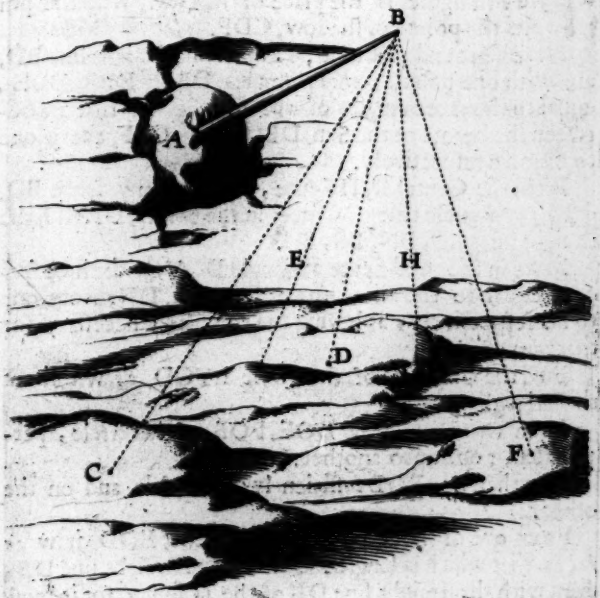
THe position or placing is given of the four points B C D F, and the placing of the two straight lines B E, B H, that divide in two the angles C B D, and D B F, and of the two ground plots that passe unto those two straight lines B E, and B H, and that are perpendicular to the ground plots of those Angles C B D and D B F, are given out; Therefore the intersection or intercutting of these two ground ploes so perpeudicular is given.

But this intercutting is the axeltree of the Dyal, therefore the position of the axeltree of the Dyal is given.

Any one may frame at his pleasure upon that which is granted concerning this composition, many other resolutions, and divers compositions of problemes, and divers general ways of practice.

In the mean time you shall have here three several ways one after another, to see which is the most advantagious for the actual practizing of the Art, and to induce you to seek or try if there is any other shorter.

For


B
A
E
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For the Theoriciens:

The Compoſition of the Probleme, or Propoſition, in Conſequence of the Reſolution made upon the lowermoſt figure of the firſt draught

THe firſt figure is the place of the Dyal, with the pin and the points of ſhadow, CDF.

Make a ground plot of it, II upon one ſtraight line BD, and with one point B, three Angles DBN, DBR, DBH, equal to the three Angles of the firſt figure, that are between the beams of the Sun, DBC, DBF, CBF, every one to his own reſpectively.

From the Center B, II figure, and from any ſpace BD, draw a half circle that may meet in the points, DNRH, the ſtraight lines BD, BN, BR, BH.

Make in the third figure a triangle DGV, with three ſpaces, equal to the three ſpaces DH, DR, DN, every one to his reſpectively, as having the condition neceſſary for that purpoſe.

Find the Center O of the circle EVGD, drawn about this triangle VGD.

Draw two Diametters DOE, POB, of this circle, perpendicular one unto another.

Lengthen one POB ſufficiently of one ſide and on the other.

From one of the ends D, from the other EOD draw as far as that which is lengthened POB one ſtraight line DB, even with the ſtraight line DB of the II figure, for it muſt reach unto it, viz. In the Equinoctial at the point O, and in an other place at an other time, lengthen ſufficiently III figure this ſtraight line BD.

Make in it the ſegments or cuttings even with the beams of the Sun of the I figure BD, BF, BC.

Take in the III figure, in the ſtraight line POB, conveniently a point I other than B.

Make

Make in the IIII figure three rods or ſticks CI, DI, FI, each of them ſharp at both ends, and equal with the three ſpaces CI, DI, FI, of the third figure.

Draw a ſtraight line along the Axeltree rod, mark in this line of the Axeltree conveniently figure IIII, one Cut BI equal with the ſpace BI of the III figure.

Set figure IIII one of the ends of the ſtick CI to the point of ſhadow, C, one of the ends of the ſtick DI to the point of ſhadow, D, and one end of the ſtick FI to the point of ſhadow F.

Let the ends of thoſe ſticks or rods be ſo well faſtened to the points of ſhadow CDF, that they cannot ſtir.

Bring together the other ends I, of thoſe ſticks in one point I.

Put one of the points B of the Axeltree rod to the point of the pin B, and the other point I with the three ends of the ſticks CI, DI, FI, ſet or joyned together. And if you have been very exact in the work, the point I of the pin will go and place it ſelf with the three ends of the ſticks ſet together in the point I, if not, you have not wrought exactly.

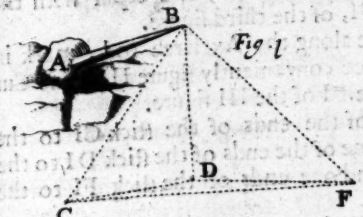

Fig. l

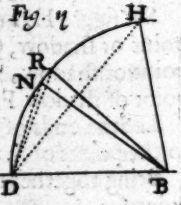

Fig. η

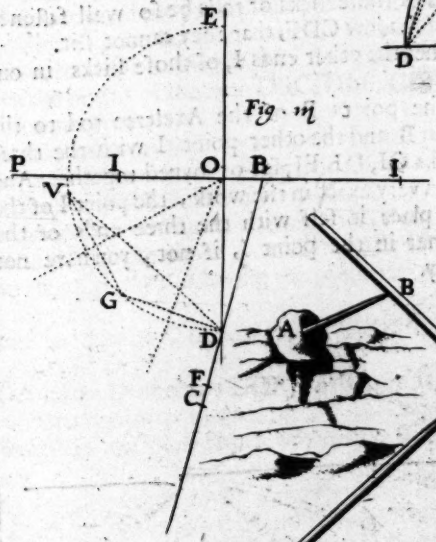

Fig. m

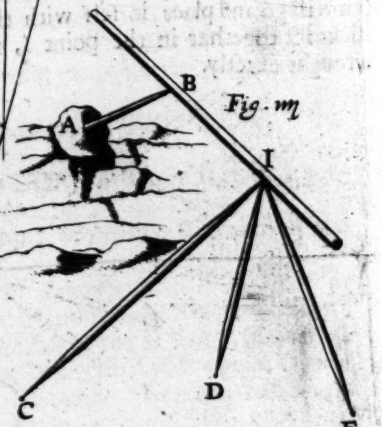

Fig. m

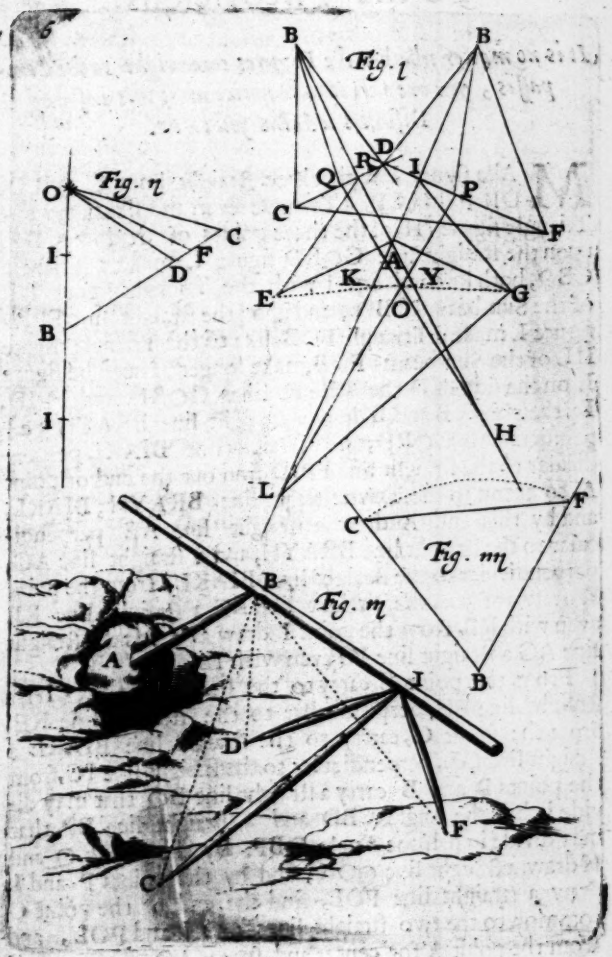
Fig. 1
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To the Theoriciens.

It is no matter whether the Figures come right to the Compasses, you are only to take notice what this insuing Discours ordains you to do.

MAke figure I with three straight lines C Q R D, D I P F, and C F, a Triangle even and like unto the Triangle figure III, of the three points of shadow C D F, upon the straight line C Q R D figure I. make a Triangle C B D, both like and equal with the Triangle figure III. of the Sun-beams C B D, and upon the straight line F P I D figure I. make a Triangle F D B, like to the Triangle figure III. of the Sun-beams F D B, make longer if need be figure I. on the side of D the straight lines C Q R D and F P I D. By the points B and B draw a straight line B R A Y H perpendicular to C Q R D, and a straight line B I A K L perpendicular to the straight line F P I D, find out the end or point A, common to these two straight lines B R A Y H, B I A K L, and by this end A draw a straight line A E perpendicular to the straight line B R A Y H, and a straight line A G, perpendicular to the straight line B I A K L, from the point R draw as far as the straight line A E a straight line R E even with R B, from the point I draw as far as the straight line A G a straight line I G even with I B.

From the point E carry to the straight line B R A I H a straight line E H, perpendicular to the straight line R E, from the point G, carry to the straight line B I A K L a straight line G L, perpendicular to the straight line I G, from the points B and B carry a straight line B Q that may divide in half the Angle C B D and a straight line B P that may divide in half the Angle D B F. By the points Q and H draw a straight line Q O H, and by the points P and L draw a straight line P O L, find the end or the point O common to the two straight lines Q O H and P O L, and from the point A for center and space A O draw an half circle that may meet with the straight lines A L in K and A H in Y.

Now

Now make in ſome other place even or flat, as in the ſecond figure in one and the ſame line BDFC three cuts BC, BD, BF, even with the Sun beams, figure III. BC, BD, BF, each of them to his own from the point B of this ſecond figure for center, and from the interval or ſpace EY or G K, of the firſt figure, draw an half Circle O from the point C figure II for center, and from the ſpace CO, of the firſt figure draw an other half Circle O from the point D of the II figure for center and ſpace DO of the firſt figure, draw an other half Circle O, and from the point F alſo of the II figure for center and ſpace FO of the I figure, draw an other half Circle O, and if you have done right, all theſe half Circles will meet in the ſame point O, if not, you have not been exact in working.

By the points B and O draw a ſtraight line BO, take in this line a point at diſcretion, firſt make three rods even with the ſpaces CI, DI, FI of the ſecond figure, and every one ſharp at both ends, make in the length of the axeltree rod figure III the ſpace BI, even with the ſpace BI of the II figure.

Laſtly ſet theſe rods to the axeltree figure III as I have ſaid at the end of the fifth table, and the axeltree of the Dyal is placed.

There are ſome ſituations of ſuperficies of Dyals, where practiſing this manner of drawing one or the other of the points LH or O comes ſo far from the ſtraight line CF, that you ſhould have need of too great a ſpace to come to it.

But in what manner ſoever the ſuperficies of the Dyal may be ſituated, and at all times or ſeaſons of the year, I mean, in any ſtrange or odd kind of example that may be found, you may work or practiſe theſe kinds of draughts with as much eaſe as in the moſt eaſy pattern.

And how irregular ſoever the example be, howſoever by the means of the points of ſhadow figure III CDF, you may make figure I an angle DBC even with the angle figure III of the beams in the Air DBC, and make alſo figure I the angle DBF even with the angle in the aire figure III of the beams DBF, and make alſo figure IIII an

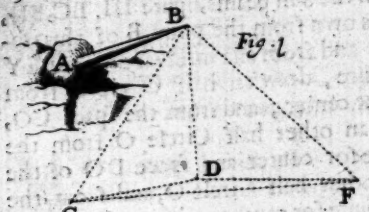

Fig. l

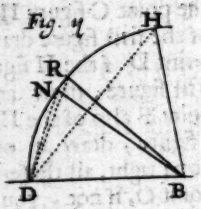

Fig. n

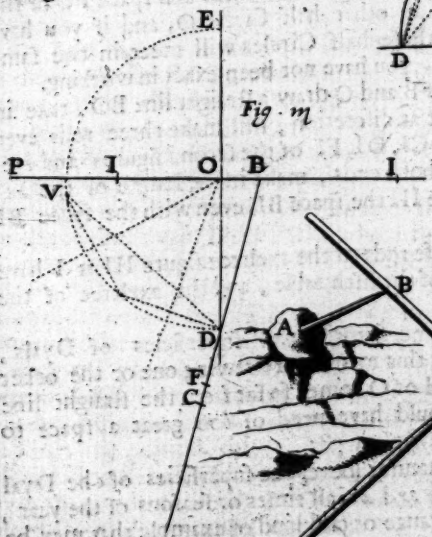

Fig. m

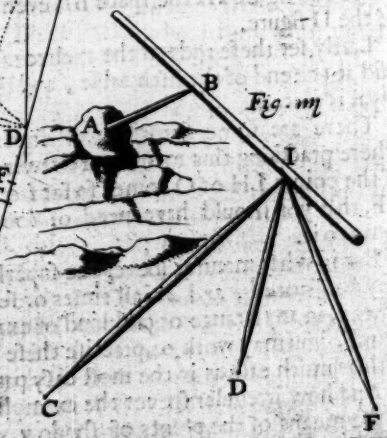

Fig. m

Now make in some other place even or flat, as in the second figure, in one and the same line B D FC, three cuts BC, BD, BF, even with the Sun beams, figure III. BC, BD, BF, each of them to his own from the point B of this second figure for center, and from the interval or space EY or GX of the first figure, draw an half Circle O, from the point C figure II. for center, and from the space CO of the first figure, draw an other half Circle O from the point D of the II. figure for center, and space DO of the first figure, draw another half Circle O, and from the point F also of the II. figure for center, and space FO of the I. figure, draw another half Circle O, and if you have done right, all these half Circles will meet in the same point O, if not, you have not been exact in working.

By the points B and O, draw a straight line BO, take in this line a point at discretion, first make three rods even with the spaces CI, DI, FI of the second figure, and every one sharp at both ends, make in the length of the axeltree rod figure III. the space BI, even with the space BI of the II. figure.

Lastly, set these rods to the axeltree figure III. as I have said at the end of the fifth table, and the axeltree of the Dyal is placed.

There are some situations of superficies of Dyals, where practising this manner of drawing, one or the other of the points LH or O, comes so far from the straight line CF, that you should have need of too great a space to come to it.

But in what manner soever the superficies of the Dyal may be situated, and at all times or seasons of the year, I mean, in any strange or odd kind of example that may be found, you may work or practise these kind of draughts, with as much ease as in the most easy pattern.

And how irregular soever the example be, howsoever by the means of the points of shadow figure III. CDF, you may make figure I. an angle DBC even with the angle figure III of the beams in the Air DBC, and make also figure I. the angle DBF even with the angle in the Air figure III. of the beams DBF, and make also figure III an

angle CBF, even with the angle in the air figure III of the beams CBF.

And by means of these three angles even with those in the air between the beams of the Sun, you may chuse at pleasure within the lines that represent those beams, other points CDF and otherwise disposed between them, then those which the shadow of the point of the pin hath given upon the superficies of the Dyal, and upon those three points chosen out at pleasure, you may make an other triangle CDF, and practise afterwards this manner of drawing as far as the triangle CBO figure II than in this triangle; and in the straight line BC, make BC, BD, BF, even with the beams in the air, BC, BD, BF, of the third figure, contained from the point of the pin B, to the points of shadow CDF in the superficies of the Dyal each of them to his own, and after you have taken, as it is said, the point I in the straight line BO, you must make use of the points CDF, last made in the triangle OCB, for to set the rods CI, DI, FI, to the axeltree BI then to work on as before.

To make other points instead of those of the superficies of the Dyal, you need only to make some at the two extremities or furthest ends CF, and make BC, and BC, equal one to the other, and unequal with the middlemost BD but a little bigger, more or lesse according as the angles DBC, DBF, are more or lesse unequal among themselves, and instead of making figure I the triangle CDF of the spaces between the points of shadow CDF of the superficies of the Dyal, you shall make it of the spaces between the points that are set in the place of these points of shadow.

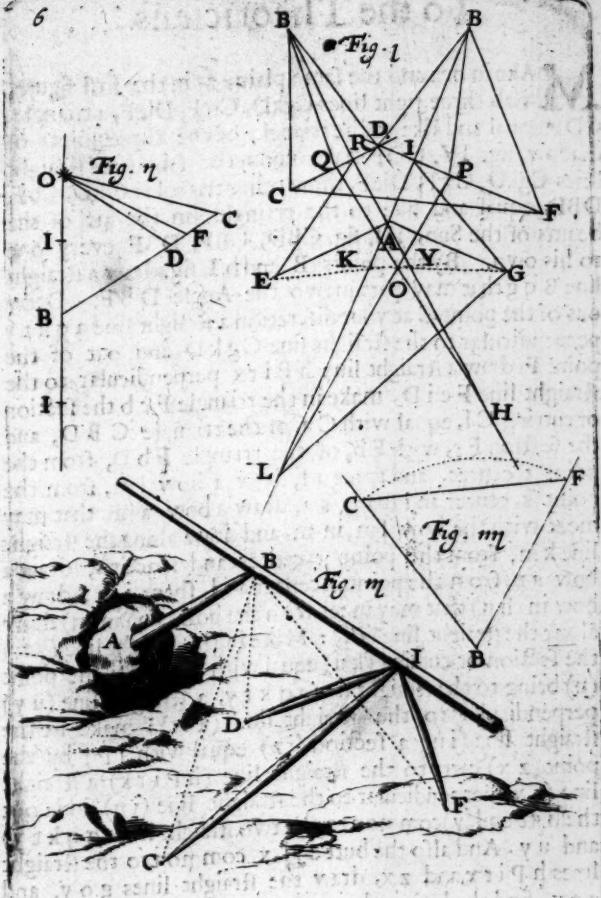
Fig. l
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Fig. n
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Fig. m
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To the Theoriciens.

MAke in one and the ſame plain, as in the firſt figure, with three right lines CgkD, CrtF, DieF, a triangle, CDF equal and like to the triangle of the three points of ſhadow, fig. IV. CDF make upon the ſaid three ſtraight lines CgkD, CrtF, DieF, three other triangles CBD, CbF, DBF, equal and like to the triangles in the air of the beams of the Sun, III. fig. CBD, CBF, DBF every one to his own. By the points B and b I. fig. draw a ſtraight line B q g that may part in two the Angle D b F. Draw out of the point C at your diſcretion a ſtraight line a q k t y perpendicular to the ſtraight line C g k D, and out of the point F, draw a ſtraight line h P i r x perpendicular to the ſtraight line F e i D, make in the triangle F c b the ſection or cutting C l, equal with C a, of the triangle C B D, and the ſection F s, with F h, of the triangle F b D, from the point t center, and ſpace t l, draw a bow l m, from the point k, center and ſpace k a, draw a bow a m, that may meet with the bow l m, in m, and draw along the ſtraight line k m, from the point r center and ſpace r s, draw a bow s n, from the point i center and ſpace i, h, draw a bow in (h n) that may meet with the bow (s n) in (n) draw along the ſtraight line (i n): Make in the ſtraight line (km) the ſection or cutting (k u) equal with k q. By the point (u) bring to the ſtraight line a q k t y, a ſtraight line (u y) perpendicular to the ſtraight line (k m); make in the ſtraight line (i n) a ſection (i z) equal with i P; by the point (z x) carry to the ſtaight line (h P i r x) a ſtraight line (z x) perpendicular to the ſtraight line (i n) finde out the butt end (y) common to the two ſtraight lines (a q k t y) and u y. And alſo the butt end x common to the ſtraight lines h P i r x and z x, draw the ſtraight lines g o y, and e o x; find the butt end o common to theſe ſtraight lines g o y, e o x.

Make in an other place figure II. a Triangle g q y, of the three ſtraight lines, as, g q, g y, and y u of the firſt figure;

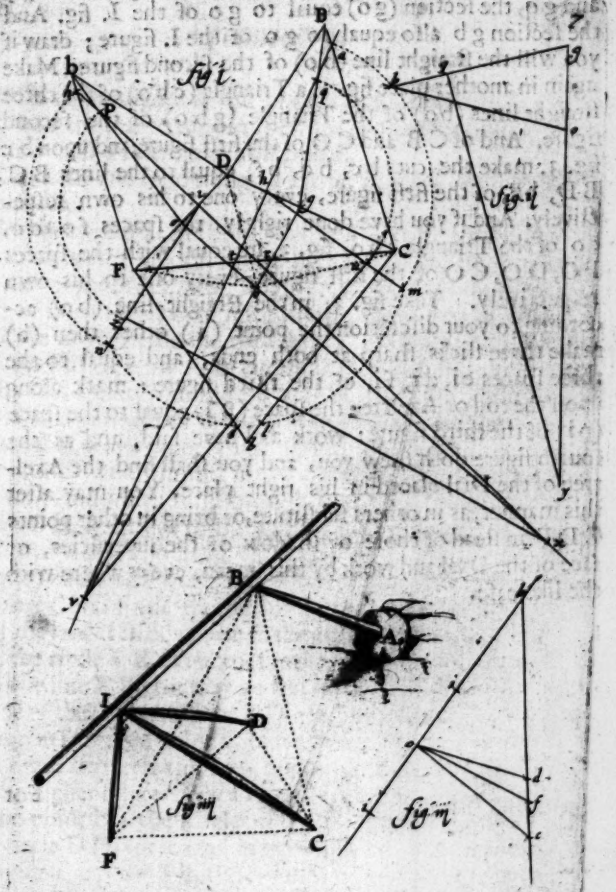
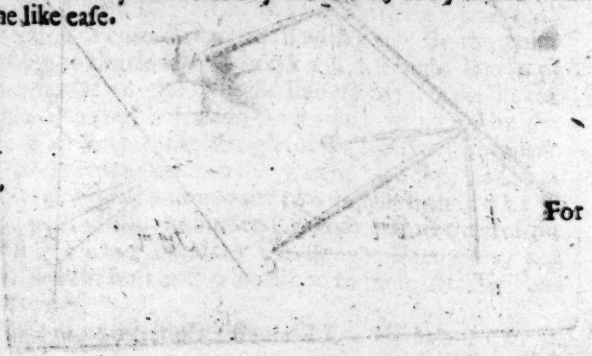


fig. i.
fig. ii
fig. iii
fig. iii
B
D
C
F
P
b
A
I

figure; make in the II. fig, and in the ſtraight lines g y and g q, the ſection (g o) equal to g o of the I. fig. And the ſection g b alſo equal to g o of the I. figure; draw if you will the ſtraight line (b o) of the ſecond figure. Make again in another place fig. 3. a Triangle (c b o) of the three ſtraight lines (b o) of the Triangle (g b o) of the ſecond figure. And of C B and C O of the firſt figure; and upon b c fig. 3. make the cuts b c, b d, b f, equal to the lines B C, B D, b F, of the firſt figure, every one to his own reſpectively. And if you have done rightly, the ſpaces f o, d o, c o of the Triangle c b o, fig. 3. are equal with the ſpaces F O, D O, C O of the firſt figure, every one to his own reſpectively. Take fig. 3. in the ſtraight line (b o) according to your diſcretion the point (i) other then (b) make three ſticks ſharp at both ends, and equal to the three ſpaces c i, d i, f i, of the third figure: mark along upon the rod or Axeltree the ſpace (B I) equal to the ſpace (b i) of the third figure: work as I have ſaid, and as the fourth figure doth ſhew you, and you ſhall find the Axeltree of the Dial placed in his right place. You may after this manner, as in others ſubſtitute, or bring in other points C D F in ſtead of thoſe of ſhadow of the ſuperficies, or face of the Dyal and work by this mean, every where with the like eaſe.



For

Figure 8;
For thoſe that have skill in Geometry.

THe higher figure is the place of the Dyal with the face unequal to the pin A B, and to the three points of ſhadow C D F, all markt, as it is ſaid.

Get a flat and ſolid thing, as a ſlate, a board, paceboard, or the like.

Draw upon it in the lower figure a ſtraight line B D F C, make in that line three cuts B C, B F, B D, equal with the three ſpaces B C, B F, B D, of the place of the Dyal, each of them to his own reſpectively, then from the point B of the lower figure for the center, and from the ſpaces B C, B F, B D, draw ſome circles D H, F E, C G.

By this means you ſee whether the ſpaces B C, B D, B F, of the higher figure or Dyal, are equal or unequal one unto another, and when theſe ſpaces are unequal among themſelves, as it happens in this example, you ſee which is the leaſt, and which is the biggeſt, as in this example, the ſpace B D, comes to be the ſhorteſt of the three.

Now from the point C of the lower figure for the center, and from the ſpace between the two points of ſhadow C and F of the higher figure, draw a circle E, that may meet in one point E, the circle of the ſpace B F, viz. the circle F E, for it muſt meet with it, then draw the ſtraight line F B, that may go and meet in one point H, the circle of the ſhorteſt ſpace B D, viz. the circle D H.

Again from the point C of the lower figure for center, and ſpace between the two points of ſhadow C and D of the higher figure, draw a circle N, that may go and meet in the point N, the circle of the ſhorteſt ſpace B D, viz. the circle D H, for it muſt meet with it.

From the point F in the lower figure for center, and from the ſpace between the two points of ſhadow F D of the higher figure, draw a circle that may meet in the point R, the circle of the ſhorteſt ſpace B D, viz. the circle D H,

for it must meet with it. By this means the three spaces or straight lines D H, D R and D N, of the circle D H, which is that of the shortest space B D, have the conditions that are requisite for the making of a triangle.

Fig.

Figure 9.

For those that are skilled in Geometry.

MAke in another place, as in the lower figure, a triangle DGV of three ſtraight lines, equal with the three ſpaces, D H, D R, D N, of the higher figure, every one to its own.

Find in the lower figure the center O of a circle, the edge whereof may reach to the points V D G, according as the lower figure doth declare.

Draw a ſtraight line D O E, through the Diameter or midd'ſt of this circle.

By the point O in the lower figure, draw a ſtraight line P O Q, perpendicular to this Diameter D O E.

From the point D in the lower figure, for the center and ſpace B D of the higher figure, draw a circle that may meet as in B, the ſtraight line Q O P, for it muſt meet with it in one or two points, viz. In the times of the Equinoxe in one point only, which is the point O, and all the reſt of the year, in two points divided on both ſides from the point O.

And that you may be exact in working, do as much on the other part, and of E for center.

Draw in the lower figure the ſtraight line B D, which in the times of the Equinoxe is joyned with the ſtraight line O D, and all the reſt of the year is divided from it, and draw along this ſtraight line B D beyond the point D.

Make in the ſtraight line B D of the lower figure two Sections B C and B F, equal to the two Sections B C, & B F of the higher figure, each of them to his own reſpectively.

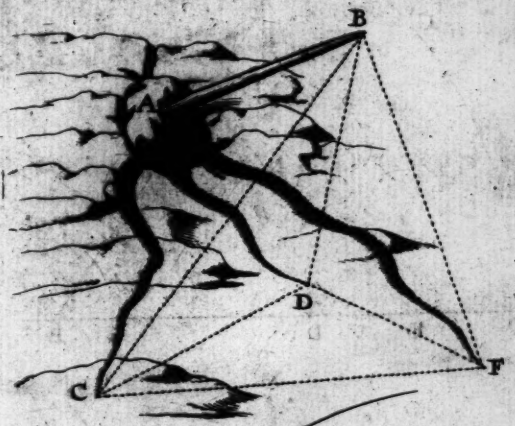
Take in the ſtraight line Q O P of the lower figure of one ſide or other of the point B, at your diſcretion, a point I, beſides the point B, and that may ſtand as far from the point B, as the occaſion may give you leave.

Figure 10.

To those that are skilled in Geometry.

THen according as the lower figure shews you, cut three sticks CI, FI, DI, sharp at both ends, and equal to the three spaces CI, FI, DI, of the higher figure, each of them to its own space respectively, and upon the rod below, whereunto you mean to make the Axeltree of the Dyal, make a Section BI, equal with the space BI of the higher figure.

Fig.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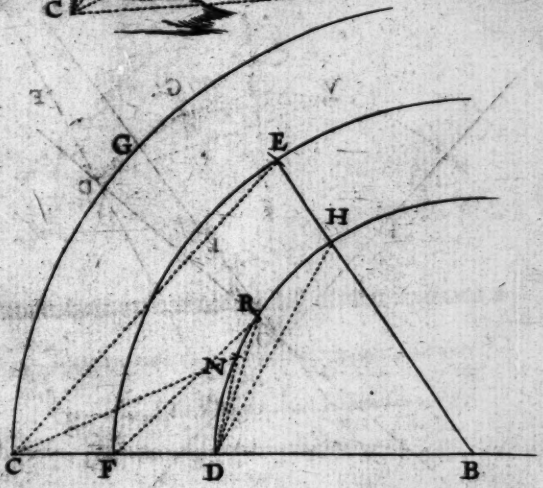
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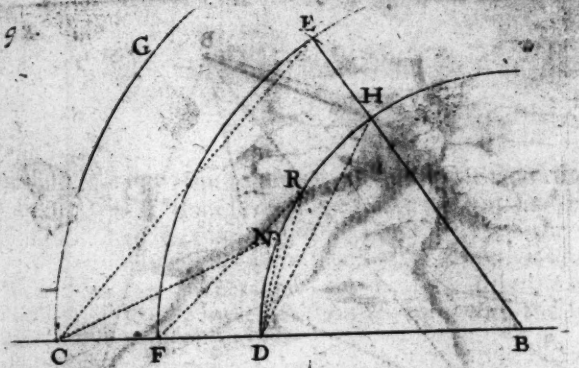
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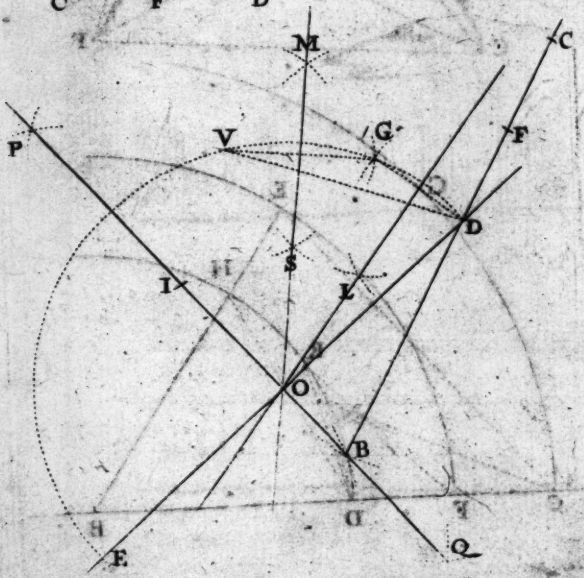
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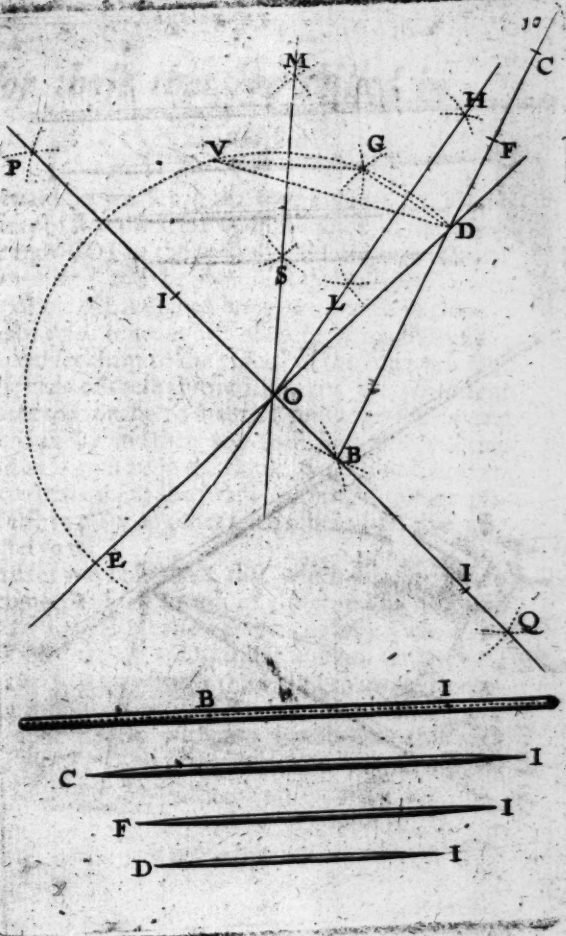
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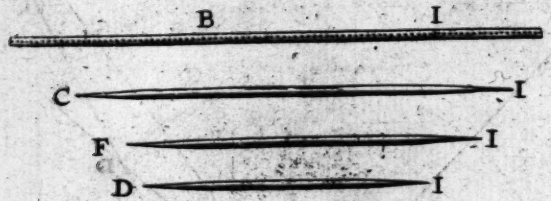
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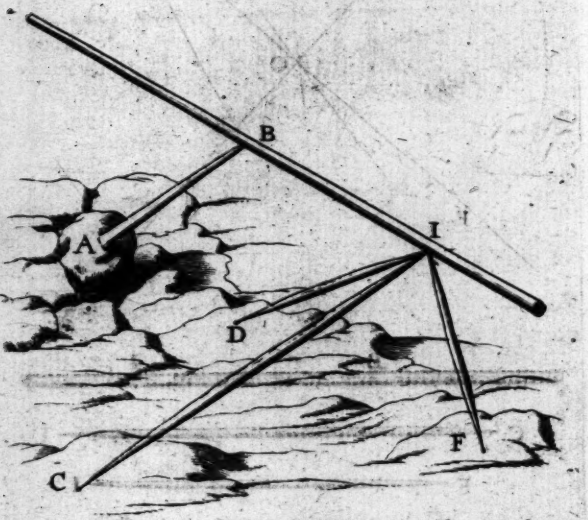
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Figure 11;

For those that are skilled in Geometry.

AFterwards as you see in the lower figure set to the points of shadow CDF upon the place of the Dyal, the three ends CDF of the sticks CI, DI, FI, each of them to his own point; and the point B of the Axeltree rod to the point of the pin AB, then bring into one point alone in the air I, the three other ends I of these three sticks CI, DI, FI, and set them to the point I of the Axeltree rod.

For the ends of these three sticks, and the point I of the Axeltree rod ought to meet all four together in one point in the air I, and then you shall find the Axeltree rod placed as it must be in the Dyal. So that you need no more but to make it fast afterwards in this position or placing, or else to place an other in an other place that may be a parallel to it.

If the matter was only about that which is sufficient to shew Geometrically the truth of the proposition, it were sufficient to have either the three sticks only without the spaceBI of the Axeltree rod, or the spaceBI of the Axeltree rod with two sticks, without a third. But to make the operation sure and effective, you can not be confident that you have done rightly without a fourth stick that may serve for a proof; This is that which *Monsieur de Sargues* had a mind to impart unto you.

Figure 8,

The ſame thing over again, but in other Terms.

To the workmen of many ſorts of Arts.

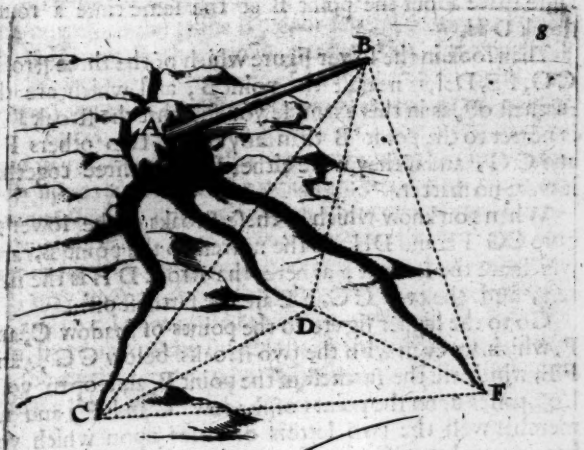
WHen you have markt the three points of ſhadow CDF in the place where you mean to make one of theſe Dyals, draw with the rule in ſome even or flat place, as you ſee in the lower figure, a line BD, FC, and make in that line a prick or point B where you ſhall think fit, or at your diſcretion.

Then go to the place of the Dyal in the higher figure, take with the Compaſſes the ſpace from the point B, of the pin A B to the point of ſhadow C. And with that ſpace come back to the line B D, F C of the lower figure, ſet one of the feet of the Compaſſes to the point B, and with the other foot go and mark in that ſame line B D an an other point or prick C, then with the ſame ſpace, give a ſtroak with the Compaſſe CG about the point B.

Go back again to the place of the Dyal above, take with your Compaſſes the ſpace from the point B, of the pin A B to the point of ſhadow F, and with this ſpace come back to the lower figure; Set again one of the feet of the Compaſſe to the point B, and with the other foot go and mark in that ſame line BC an other prick or ſtay F, and draw again about the point B with the ſame ſpace of the Compaſſe this half circle FE.

Go back again to the figure above, take with your Compaſſes the ſpace from the point B of the pin A B, to the point of ſhadow D, and with this ſpace come back to the lower figure and put again one of the feet of the Compaſſe to the point B, and with the other foot, make in the

line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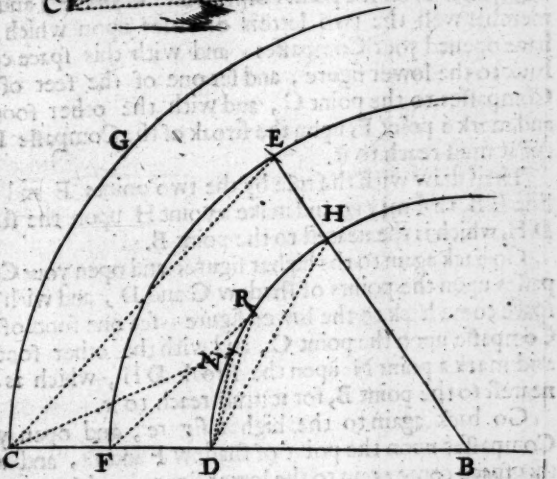
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line B C an other prick or ſtay D, and draw again with the ſame ſpace about the point B at the ſame time a round ſtroak D H.

Then look in the lower figure which of the three ſtroaks C G, F E, D H, is neareſt the point B, and which are the furtheſt off, as in this example you ſee that the ſtroak D H is nearer to the point B than any of the two others F E and C G, and if they were either two or three together it were no matter.

When you know which of theſe ſtroaks of the lower figure C G F E and D H, is the neareſt to the point B, and which are the fartheſt, as here, the ſtroak D H is the neareſt, and the two C G, F E are the fartheſt off.

Go to the higher figure to the points of ſhadow C, and F, which are even with the two ſtroaks below C G, and F E, which are the furtheſt off the point B, and open your Compaſſes upon the points of ſhadow C and F, and remember well the two letters or cotes upon which you have opened your Compaſſes, and with this ſpace come back to the lower figure, and ſet one of the feet of the Compaſſes to the point C, and with the other foot go and mark a point E, upon the ſtroak of the Compaſſe F E, for it muſt reach to it.

Then draw with the rule by the two points E and B, a line E B, that may go and make a point H upon the ſtroak D H, which is the neareſt to the point B.

Go back again to the higher figure, and open your Compaſſes upon the points of ſhadow C and D, and with this ſpace come back to the lower figure, ſet one foot of the Compaſſe upon the point C, and with the other foot go and mark a point N upon the ſtroak D H, which is the neareſt to the point B, for it muſt reach to it.

Go back again to the higher figure, and open your Compaſſes upon the point of ſhadow F and D, and with this ſpace come again to the lower figure, and ſet one foot of the Compaſſe upon the point F, and with the other foot go and make a point R upon the ſtroak D H, which is the neareſt to the point B, for it muſt reach to it.

After that, you have no more to do upon the place of

the Dyal, till you place the Axeltree as it ought to be, and you have in the lower figure upon the ſtroak DA, which is the neareſt to the point B, four ſeveral points of ſhaws D N R H to make three point perdus with, as you ſhall ſee, in the mean time remember when you open the Compaſſe upon the points of ſhadow in the place of the Dyal, to take great notice upon what letters you have opened your Compaſſe, that you may apply the ſame ſpace below upon the two ſtroaks which are equal with the two points of ſhadow upon which you have opened your Compaſſe, and ſet one foot upon one of the ſtroaks, and the other upon the other ſtroak. And moreover that the points N R, may well come out from betwixt the points D and H; and that I have cauſed them to come in ſo betwixt them, by reaſon of the ſmallneſſe of the place, and what way ſoever they come to be diſpoſed, it is but one and the ſame thing ſtill.

The

Fig. 9.

To the workmen of many ſorts of Arts.

SEt your Compaſſe upon the points D, and H, of the higher figure, and with that ſpace go to ſome flit or even place in the lower figure, and make two points D, and V, ſo that the ſpace D V below, may be even with the ſpace D H above.

Then go to the figure above, and ſet your Compaſs upon the points D and R, and with this ſpace come back to the figure below, and ſet one foot of the Compaſſe to the point V, and with the other foot draw a line from the point D, to the point G, ſo that the ſpace V G below, may be even with the ſpace D R above.

Go back again to the figure above, and ſet your Compaſs to the points D & N, and with this ſpace come back to the lower figure, & ſet one foot of the Compaſs to the point D, and with the other foot draw a line from the point V, to the point G, ſo that the ſpace D G below, may be even with the ſpace D N above, and may meet in G the other circular line that you have drawn about the point V, for it muſt meet with it.

i. e. That are made without any aim, or heed.

And ſo you have made in the lower figure three points V G D that will be perdus or loſt.

Now find a center O, upon which having ſet one of the feet of the Compaſs, and the other upon D, let this foot in turning the Compaſs about, go and paſſe by thoſe three points perdus V G D, then draw with the rule by the points, as it were O and D, a line D O E, and ſetting again one foot of the Compaſs to the point O, and turning the other foot to E, make in the line D O E, the ſide O E, even with O D.

Then by the point O, draw a line Q O P, that may cut the line D O E, in two equal parts; again ſet your compaſs to the points B, and D, of the figure above, and with this ſpace go to the figure below, ſet one foot of the compaſs to the point D, & with the other foot draw from the point E, a line B, that may meet as it were in the point B, the line Q O P, and make with this other foot of the compaſs a point B, in the line Q O P, for it muſt meet with it, if you have done exactly.

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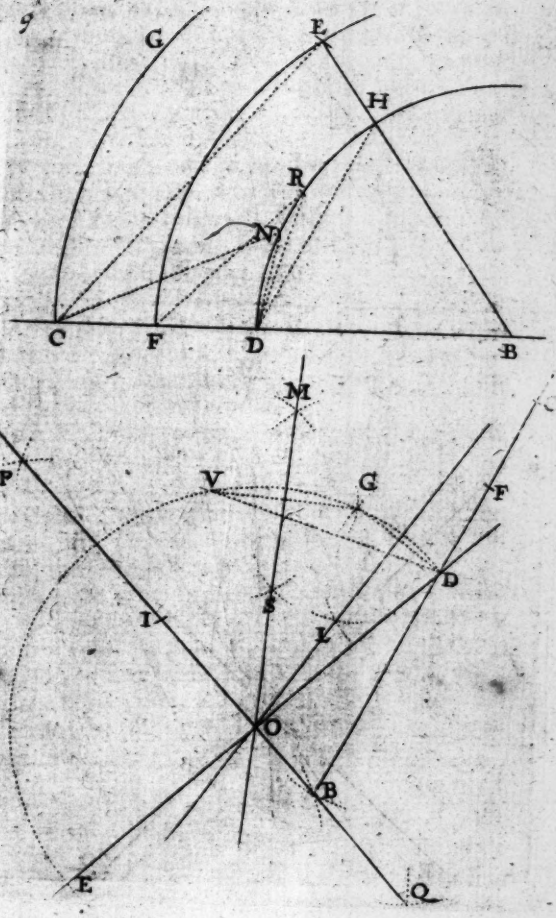
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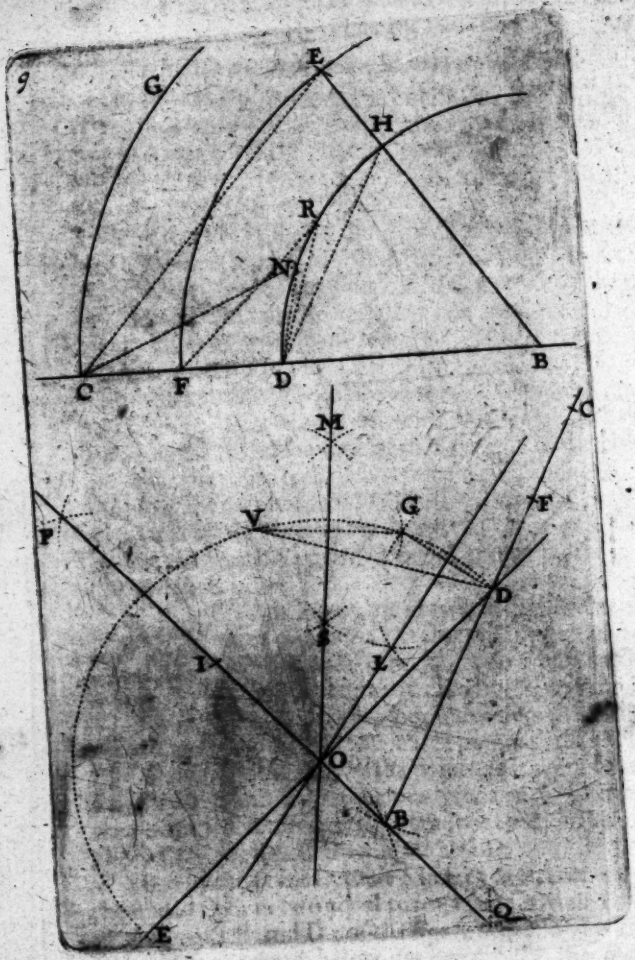
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When the dayes and the nights are equal, it meets with it in one point alone, viz. O, and at ſome other times it meets in two points, one of one ſide of the O, and the other on the other ſide, as in the point E. Then remove your Compaſs out of his place, and with the ſame ſpace of the points B and D of the figure above, ſet one foot of the Compaſs to the point E, and with the other foot draw from the point D, with your Compaſs another line B, that may go and meet the line Q O P, with the line that you have traced with the Compaſs about the point D, and both of them in one and the ſame point B, for it muſt do it if you have been exact: And that ſerves to mark more exactly this point B, in the line Q O P, how neer ſoever it is to the Point O. After that, Whether the Point B of the lower figure meets with the Point O or not, draw with the rule by the points B and D, the line B D, and draw this line B D, as you ſee beyond the point D.

That being done, open your Compaſs upon the points B and C, of the higher figure, and carry this ſpace to the line B D of the lower figure, and from B into C.

Set your Compaſs again upon the points B and F of the higher figure, and bring this ſpace to the line B D of the lower figure, and from B into F.

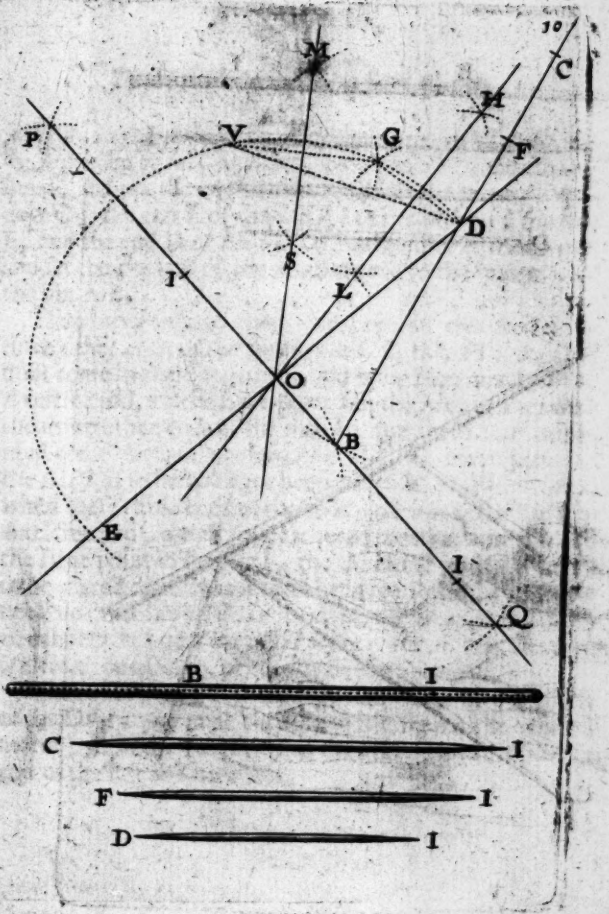
And finally make in the line Q O P, a point I, at your diſcretion of one ſide or other of the point B, and let it be as far diſtant from the point B, as occaſion will give you leave. And ſo you have in this lower figure from the point I to every one of the points B D F C, all the meaſures that are neceſſary for the placing of the axeltree or needle in your Dyal, in the manner hereafter following.

Fig

Figure 10,

To the workmen of many sorts of Arts.

Take three rods or sticks sharp at both ends as you see below, one C I of the length that is betwixt the point C, and the point I of the figure above, the other F I of the length that is betwixt the point F, and the same point I of the higher figure, the other D I of the length that is betwixt the point D, to the same point I of the higher figure, then open your compasse upon the points B and I of the higher figure, and bring down this space upon the Axeltree rod, and make in the same as you see, two points B and I with this same space B I of the figure above.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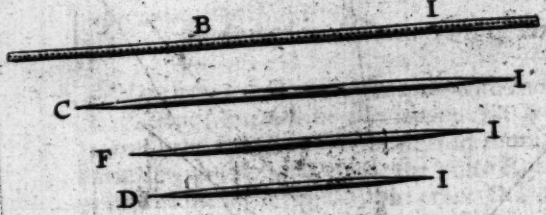
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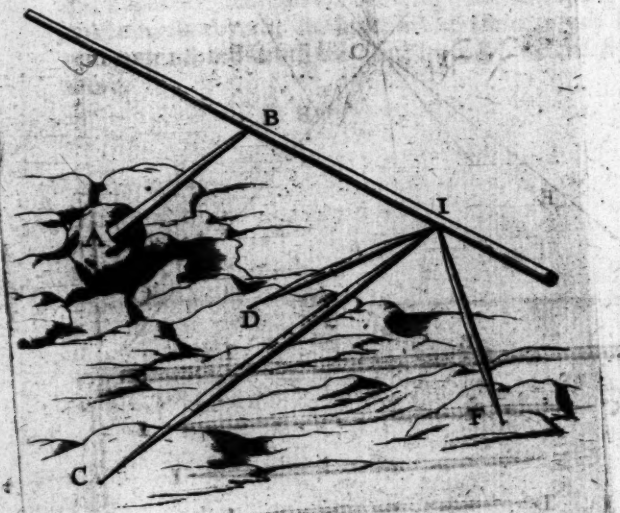
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Figure 11,

To the workmen of many sorts of Arts.

GOe to the place of the Dyal below which I have expressed again, a purpose to avoid the confusion of lines, and put the end of the rod C I to the point of shadow C, the end F of the rod F I to the point of shadow F, and the end D of the rod DI to the point of shadow D, and set the point B of the Axeltree rod to the point B of the pin A B.

Then bring together into one point in the Air I, the three other ends of the three rods C I, DI, FI, for they must come in there together, and bring the point I, of the Axeltree rod, to the same point I in the Air together with the three other ends of the rods I, for these four things must come alltogether into one and the same point in the Air I, if so be you have been exact in working. And when these three ends of the rods and the point I of the Axeltree rod, are all four gathered together into one and the same point in the Air I, the Axeltree rod will come to be placed directly as it must be in the Dyal, and so you need no more but to make it fast in that place, or to fasten an other either near it or farr from it, that may be even with it, or parallel to, or equally distant from it.

If the four points I should go and meet in the body of the Dyal, you must but take in it's figure the point I nearer, or in the other side of the point B, and make an end of the rest as I have said.

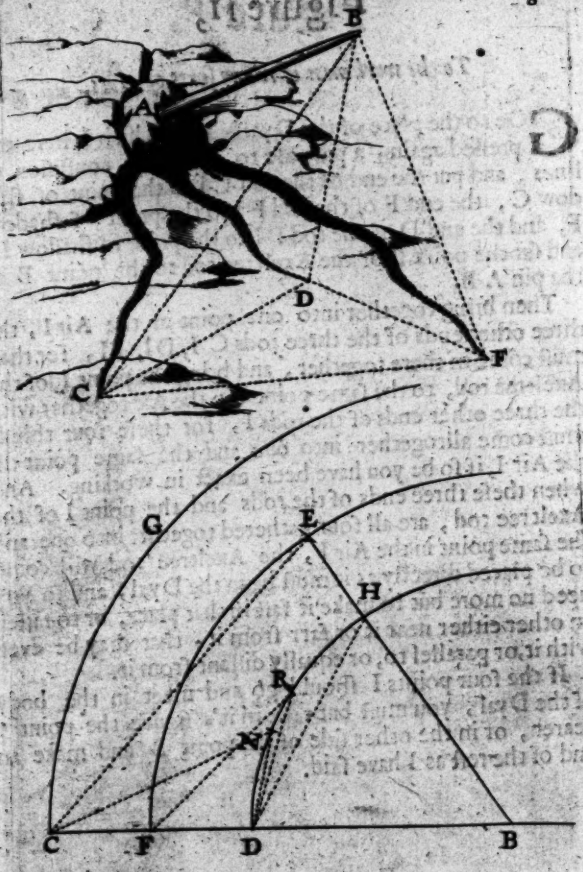
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Figure 8,

I will say the same thing over again, but more at large.

To all sorts of People that have neither skill in Geometry nor in Arts; but are apt and fit to learn them both.

BEfore you undertook to make this Dyal, you had nothing about you, nor knew nothing wherewith to further you in it, and going about it, you have made use of the pin A B, as it were at a venture.

Now you must consider that having placed the pin A B, in this manner, you have given out of your self in the end thereof a point alone unmovable and fixed in the air.

Then by means, of this fixed point in the air B, and of the Sun-beams, you have found out three other unmovable and fixed points of shadow C D F, on the outward face of the place where you have a mind to make your Dyal: So you see that by means of this end of pin B, and of the Sun-beams, you have established upon the place where you intend to make your Dyal four points fixed and divided one from another, viz, one in the Air, which is the point or the end B of the pin A B, and three in the superficies of the Dyal which are the three points of shadow C D F.

Whereby you have found also six spaces, that is to say, the lengths of six straight lines unmoveable, fixed, distinct, and divided one from the other.

For if you consider well, you shall see that you have found out by this means the spaces, or lengths, or distances that are from the point B of the pin A B, to every one of the three points of shadow C D F, viz. the space from the point of the pin B to the point of shadow C, the space

from the ſame point of the pin B to the point of ſhadow D, and the ſpace again from the ſame point of the pin B to the point of ſhadow F.

And for your better inſtruction, if you will make theſe three lines viſible to the eye, ſet unto every one of them either a ruler or a ſtring ſtretch'd out in a direct line from the point of the pin B, to every one of the points of ſhadow C D F, as the points do ſhew it unto you; And ſo you may ſee the three lines B C, B D, B F, which otherwiſe are inviſible in the Air.

And beſides theſe three ſpaces or lengths, you have alſo found out the three ſpaces or lengths that are from every one of the three points of ſhadow C D F, unto the other, viz. the ſpace from the point of ſhadow C, to the point of ſhadow F, the ſpace from the point of ſhadow C, to the point of ſhadow D, and the ſpaces from the point of ſhadow F to the point of ſhadow D, as you may ſee by the points that are there. So you have ſix ſpaces or lengths B C, B D, B F, C F, C D, D F, which you have already found unmovable, and fixed to the place wherein you intend to make your Dyal, which are ſo great a furtherance unto your work, that there remains nothing elſe to do, but by the help and means of the ſaid ſix ſpaces or lengths, to find alſo three or four more, that you may have all that is requiſite for the placing of the Axeltree rod of your Dyal as it ought to be.

You muſt know that there are ſeveral wayes whereby theſe ſix ſpaces which you have found already, viz, B C, B D, B F, C F, C D, D F, are made uſe of to find out thoſe three or four more, which you muſt have to inable you to place the Axeltree rod of your Dyal as it muſt be.

And that of all thoſe ſeveral wayes a man may have a liking to one for one reaſon, and another man to an other for ſome other reaſon, and of thoſe ſeveral wayes *Monſieur de Sargues* hath ſhewed me three or four at the moſt, viz. that which he hath ſet down in the figure of his model or project page, and of the others for which you muſt know how to make ſometimes ſomekind of alteration, and which I have ſet down in ſhort, there is one in the fifth figure, and another in the ſeventh.

As

As for this it is such, that there is no occasion but you may practise it in effectually, and with the like ease every where, without you need either to add or alter any thing, as you shall see presently.

Draw with the rule, as you see in the figure below in some flat or even place a straight line B D, F C, then go to the figure above, and open your Compasse, and set one of the feet to the point B of the pin A B, and the other foot to the point of shadow C, and by that means you shall take with your Compasse the space or the lengths that are from the point of the pin B, to the point of shadow C, whereof you will be pleased to remember, to the end that when I shall bid you for brevity sake, take after the same manner with your Compasse such a space, you may be able to do with your Compasse even as I told you just now of the space B C in the figure above.

Now with this space BC of the figure above, come back to the figure below, and set at your discretion one of the feet of the Compasse upon the straight line that you have drawn there, as for example set it to the point B, then turning the Compasse about upon this point B, draw with the other foot a circular line C G, which circle by this means shall have a space B C equal with the space B C of the higher figure, and will meet the line BD for example in the point C.

Go back again to the figure above, take there after the same manner the space from the end or point of the pin B to the point of shadow D, and with this space come back to the figure below, and set again one of the feet of your Compasse to the point B, and holding it still upon this point B draw with the other foot a second circular line D H, that will be equal with the space above B D, and that may meet the line B G, for example in the point D.

Go back again to the figure above, and take with your Compasse the space betwixt the point of the pin B and the point of shadow F, and with this space come back to the figure below, set one of the feet of the Compasse to the point B, and draw with the other foot a third circular line F E, with the space B F of the figure above, and that may

meet

meet the line B D for example in the point F.

By this means you have ſet away and tranſported the three ſpaces B C, B D, B F, from the riſe or place which they had in the place of the Dyal above in a flat and even place below; and all of them united together in one ſingle line B D F C, in which you may ſee whether thoſe ſpaces be equal amongſt themſelves, as they may be in ſome occaſions which is indifferent, or whether they be unequal, by ſeeing whether the points C D F, are united together two or three in one ſingle point, or whether they are diſunited or divided one from another, and when theſe three points C D F, are diſunited or divided one from the other which happens moſt commonly, and that theſe three ſpaces B C, BD, B F, are unequal amongſt themſelves, as it falls out in this example, you ſee which of theſe ſpaces are the greateſt and which is the leaſt, conſidering which of theſe three points C D F is the neareſt, and which is the furtheſt from the point B, that is to ſay alſo that by this means you ſee which of theſe circular lines C G, E F, DH, is neareſt to the point B, and which are furtheſt as in this example you ſee that of the three ſpaces B C, B D, B F, thoſe two B C and B F, are the greateſt, and B D is the leaſt; and of the three half circles C G, F E, D H, you ſee that D H is the neareſt to the point B, and that the circle F B is nearer to it than the circle C G.

When you have thus found out which of the three ſpaces BC, BD, BF is the leaſt, and which of the three circles C G, F E D H is the neareſt of the point B. Go back again to the higher figure to the points of ſhadow C D F, and take with the compaſſe the ſpace betwixt the points of ſhadow C and F, which are at the ends of the two greateſt ſpaces B C and B F, and with this ſpace C F of the higher figure, go to the lower figure to the ſame point C F, and ſet one foot of the compaſſe upon either of thoſe points C and F, that is the furtheſt from the point B, viz. C, and holding ſtill the point of the compaſſe upon this point C, go and mark with the other foot a point for example E, in

the

the circle of the other of theſe two points C and F, viz. in the circle of the point F, which is the circle F E, for this other foot of the compaſſe muſt reach to this circle of the point F, as for example in the point E; This being done, draw by this point E to the point B a ſtraight line EB, that may go and meet, in one point H the circle of the point D which is the neareſt to the point B, and mark in it this point H.

Then go to the figure above, and take with the compaſſe the ſpace betwixt the two points of ſhadow C and D, and with this ſpace C D of the figure above go to the figure below, to the ſame points C and D ſet one foot of the compaſſe to that point of theſe two C and D, which is the furtheſt from the point B, viz. C, and keeping this foot of the compaſſe upon this point C, go and mark with the other a point, for example N in the circle of the other of the two points C and D, viz. in the circle of the point D with the circle D H, for this other foot of the compaſſe muſt reach to the circle of the point D, for example in the point N.

Go back to the figure above, take with your compaſſes the ſpace betwixt the two points of ſhadow F and D, and with this ſpace F D of the figure above, come back to the figure below to the like points F and D ſet one foot of the compaſſe upon that point of theſe two F and D, which is furtheſt from the point B, viz. F and holding ſtill the point of the compaſſe upon this point F, go and mark with the other foot a point for example R, in the circle of the other of theſe two points F and D to wit, in the circle of the point D which is the circle D H, for this other foot of the compaſſe muſt reach to the circle of the point D, for example in the point R. This being done, you have no more to do in the place of the Dyal, till you go and place the Axeltree rod in it as it muſt be, and in the figure below in the circle of the point D, which is neareſt to the point B, you have found by this means four points D N, R H, different and divided one from the other, and when the two points N and R ſhould be found united together, it were no matter. Now by the means of theſe four points you have

have three spaces amongst others from the point D, to every one of the three points H R and N to wit, the space from D to H, the space from D to R, and the space from D to N, of which spaces you see which is the greatest and which is the least, when they are all three unequal, as in this example, for it may happen that there will be two found equal amongst them.

And with the help of these spaces D H, D R, D N, you shall find presently those four that you must have for the placing of the Axeltree rod of your Dyal, as it ought to be.

Fig.

Figure 9,

To all ſorts of People:

TAke with the Compaſſe in the figure above, of theſe three ſpaces D H, D R D N, that ſame that is the greateſt of all, as in this example here, the ſpace D H and with this ſpace D H of the higher figure, go to ſome place that is flat, as in the figure below, and ſet at the ſame time the two feet of the Compaſſe upon it, as for example, to the two points D and V, and mark theſe two points as it were D and V, which by this means will be diſtant one from the other, the length of the ſpace D H of the figure above.

Go back again to the figure above, take there with the Compaſſe the ſpace from D to R, and with this ſpace go to the figure below, ſet one of the feet of the Compaſſe to the point V, and from thence draw with the other foot towards the point D a circle G, which by this means ſhall be made of the ſpace D R of the figure above.

Go back again to the figure above, take with the Compaſſe the ſpace from D to H, and with this ſpace go to the figure below, ſet one of the feet of the Compaſſe to the point D, and from thence with the other foot draw towards the point V another circular line that may meet, for example, in G the other circle, which you have drawn about the point V, for this other foot of the Compaſſe muſt meet the other circle in one or two points, and for example, in the point G for one.

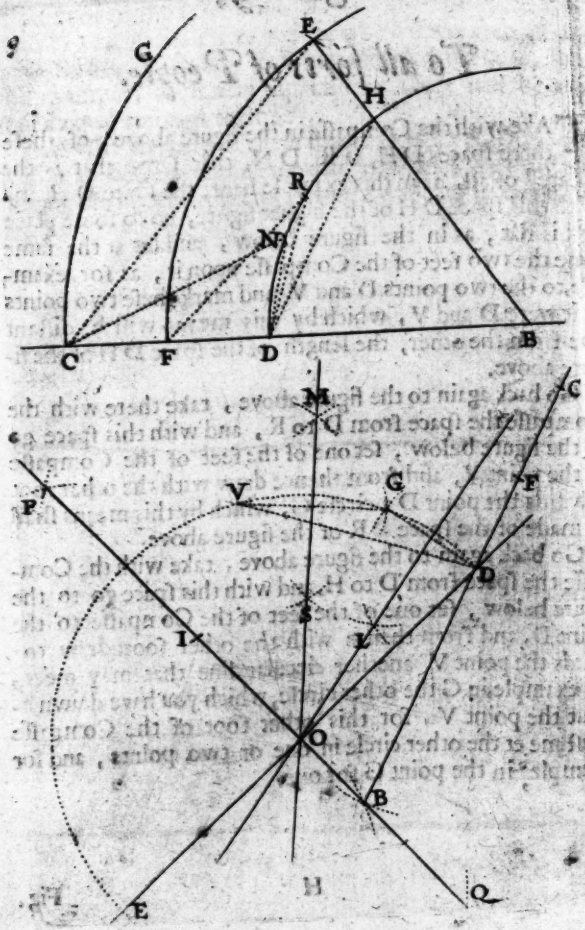
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Figure 9,

To the workmen of many ſorts of Arts.

SEt your compaſſe upon the points D and H of the higher figure, and with that ſpace go to ſome flat or even place in the lower figure, and make two points D and V, ſo that the ſpace D V below, maybe even with the ſpace D H above.

Then go to the figure above, and ſet your compaſſe upon the points D and R, and with this ſpace come back to the figure below, and ſet one foot of the compaſſe to the point V, and with the other foot, draw a line from the point D to the point G, ſo that the ſpace V G below, may be even with the ſpace D R above.

Go back again to the figure above, and ſet your compaſſe to the points D and N, and with this ſpace come back to the lower figure, and ſet one foot of the compaſſe to the point D, and with the other foot draw a line from the point V to the point G, ſo that the ſpace D G below, may be even with the ſpace D N above, and may meet in G the other circular line that you have drawn about the point V, for it muſt meet with it.

And ſo you have made in the lower figure three points V G D, that will be perdus or loſt.

Now find a Center O, upon which having ſet one of the feet of the compaſſe, and the other upon D, let this foot in turning the compaſſe about go and paſſe by thoſe three points perdus V G D, then draw with the rule by the points, as it were, O and D, a line D O E, and ſetting again one foot of the compaſſe to the point O, and turning the other foot to E, make in the line D O E, the ſide O E, even with O D.

Then by the point O, draw a line Q O P, that may cut

the line D O E in two equal parts. Again, ſet your compaſſe to the points B and D of the figure above, and with this ſpace go to the figure below, ſet one foot of the compaſſe to the point D, and with the other foot draw from the point E a line B, that may meet as it were in the point B the line Q O P, and make with this other foot of the compaſſe a point B in the line Q O P, for it muſt meet with it, if you have done exactly.

When the dayes and the nights are equal, it meets with it in one point alone, viz. O, and at ſome other times it meets in two points, one of one ſide of the O, and the other of the other ſide, as in the point E, then remove your compaſſe out of his place, and with the ſame ſpace of the points B and D, of the figure above ſet one foot of the compaſſe to the point E, and with the other foot draw from the point D with your compaſſe another line B, that may go and meet the line Q O P, with the line that you have traced with the compaſſe about the point D, and both of them in one and the ſame point B, for it muſt do it if you have been exact, And that ſerves to mark more exactly this point B in the line Q O P, how near ſoever it is to the point O. After that, whether the point B of the lower figure meets with the point O or not, draw with the rule by the points B and D the line B D, and draw this line B D, as you ſee, beyond the point D.

That being done, open your compaſſe upon the points B and C of the higher figure, and carry this ſpace to the line B D of the lower figure, and from B into C.

Set your compaſs again upon the points B and F of the higher figure, and bring this ſpace to the line B D of the lower figure, and from B into F.

And finally make in the line Q O P a point I, at your diſcretion, of one ſide or other of the point B, and let it be as far diſtant from the point B, as occaſion will give you leave; And ſo you have in this lower figure from the point I, to every one of the points B D, F C, all the meaſures that are neceſſary for the placing of the axeltree or needle in the Dyal, in the manner hereafter following.

Fig.

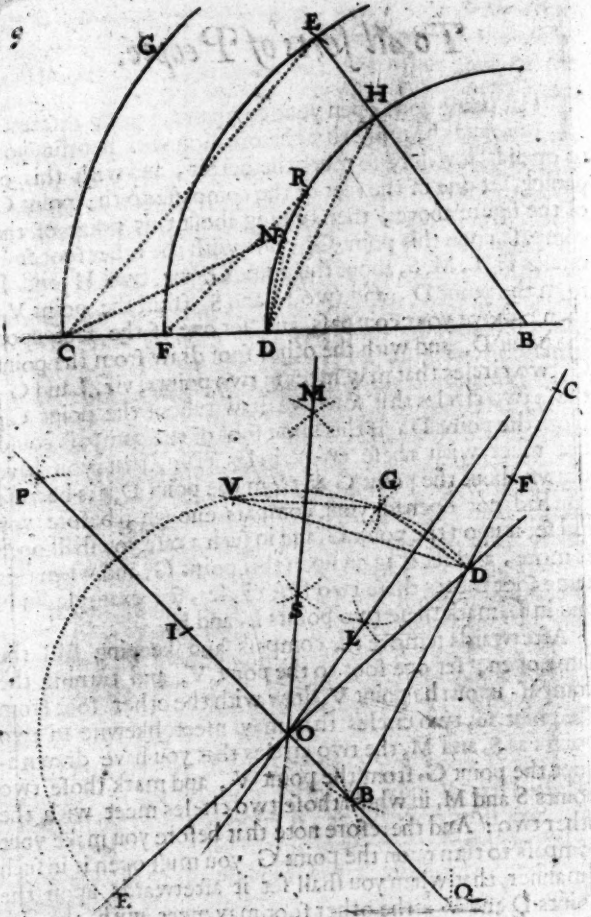
Figure 9,

To all ſorts of People.

THat being done open your compaſſe at your diſcretion, and the more that the occaſion will permit you to open it, it will be ſo much the better, and with this opening, ſet one of the feet of the compaſſe to the point G of the figure above, then turning about this point of the compaſs upon this point G, draw with the other foot four circles H, L, M, S, about the point G. viz. two H, and L from the point D, and two M and S from the point V, then remove your compaſs, and ſet one of the feet upon the point D, and with the other foot draw from the point G, two circles that may meet in two points, viz. L and G, thoſe two circles that you have drawn about the point G, from the point D, if this ſame foot of the compaſs could not meet with theſe two circles H L, that you have drawn about the point G & from the point D, it is becauſe you had not opened your compaſs enough, before you did ſet it upon the point G, and in ſuch a caſe you ſhall open it more, and ſet it again upon this point G, and when this ſame foot meets theſe two firſt circles, for example, in H and in L, mark theſe two points L, and H.

Afterwards remove the compaſs and keeping ſtill the ſame open, ſet one foot to the point V, and turning the compaſs upon the point V, draw with the other foot from the point G, two circles that may meet likewiſe in two points as S, and M, the two circles that you have drawn about the point G, from the point V, and mark thoſe two points S and M, in which thoſe two circles meet with the other two: And therefore note that before you make your compaſs to turn upon the point G. you muſt open it in ſuch a manner, that when you ſhall ſet it afterwards upon the points D and V, the other foot may meet with the circles that you have drawn about the point G.

Then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Then draw by the two points H and L, a long ſtraight line H, L, O, and by the two points S and M, draw another long line and as ſtraight, M, S, O, and theſe two lines H L and M S, being ſufficiently drawn at length, will meet in one and the ſame point O.

By the two points D and O, draw a ſtraight line D O, and draw it at length, as you ſee from the point O, then ſet one of the feet of the compaſs upon the point O, and the other foot upon the point D, and turn that foot of the compaſs which is upon the point O. The other foot which is upon the point D muſt go and touch every one of the points G and V, and when this other foot hath gone over the point D, G, V, go and mark at the very ſame time with it a point, as E in the line D O E, and ſo you ſhall make the portion O E of the line O D, equal with the portion O D.

Then open your compaſs at diſcretion more than from the ſpace O D, and as much as the occaſion will give you leave, the more the better, and the compaſs being ſo open at diſcretion, ſet one of the feet to the point D of the lower figure, and turning that foot of the compaſs upon the point D, draw with the other foot from the point O, two circles, as P and Q then remove the compaſs, keeping ſtill the ſame diſtance, ſet one foot upon the point E, and turning it about, draw with the other foot from the point O, two other circles, that may meet in two points with the two circles that you have drawn about the point D, and as for example in the two points Q and P, and draw with the rule by theſe two points, as Q and P, a long ſtraight line Q P, that muſt reach to the point O, if you have been very exact in the working; if it doth not reach to it you have not been very exact, and I adviſe you to begin it again: If it reaches to it, go back to the figure below, and take with the compaſs the diſtance between B and D, then with this ſpace go to the figure below, ſet one foot of the compaſs upon the point D, and turning it about, draw with the other foot from the point O, a circle that may meet the line Q O P, as for example in the point B, for this other foot of the compaſs muſt go and meet that ſtraight line

P O Q

P O Q either in one or in two points, because the space from B to D of the higher figure ought never to be smaller or lesser than the space D O of the figure above.

It is true that twice in the year, viz. in *Autumne* and in the *Spring*, when the dayes and nights are equal, that space B D of the figure above, comes to be equal with the space D O, of the figure below, and in those times that other foot of the Compasse that turns about the point D of the figure below, meets the line Q O P just in the point O. But at all other times the space B D of the figure above is somewhat bigger than the space D O of the lower figure; And then the other foot of the Compasse that turns about the point D, meets the line Q O P, in two points, one of each side of the point O, as for example in B, for one.

And that you may be the more exact, remove the Compasse from one part of the straight line B O unto the other, and with the same opening of the space B D of the higher figure, set one of the feet upon the point E of the figure below, and turning this foot upon this point E, draw with the other and from the point D an other circle that will meet (if you have been exact in the working) the straight line Q O P, and the circle also that you have drawn about the point D, and both in one point; as for example in the point B, which will inable you to discern well the point B in the straight line P O Q; mark this point B in the line P O Q, whether you find it united with the point O, and so both of them making but one and the same point, as it falls out, when the days and nights are equal, or whether you find it divided from the point O, as it falls out in other seasons, and as you see in this example; Then draw with the rule by these two points B and D a straight line B D, which you shall stretch out sufficiently beyond the point D. When the days and nights are equal, as in *Autumne* and in the *Spring*, and that the point B is found to be united with the point O, the line B D comes likewise to be united with the line O D, and both together make but one line; But at any other time, as the two points B and O are two several points and divided one from the other, so the two lines

lines B D and O D, are two several lines, and divided one from the other,

This being done, go to the figure above, measure with your Compasse the space from B to C, and with this space go to the figure below, set one foot of the Compasse upon the line B D, to the point B, and set the other foot in any place of the same line B D where it may light upon; as for example in the point C, by this means you shall make the portion B C, of the line B D of the lower figure, equal with the portion B C, of the line B D of the higher figure, make after the same manner with the Compasse, the portion B F, of the line B D of the lower figure, equal to the Portion B F, of the line B D of the figure above.

Finally, in the same figure below, and in the line Q O P, mark at your discretion another point I, of one side or other of the point B, according as you shall find it most convenient for the place of the Dyal, and as far from this point B, as occasion will permit, the further the better, and so you have found the four spaces that you wanted for the perfect placing of the Axeltree of your Dyal.

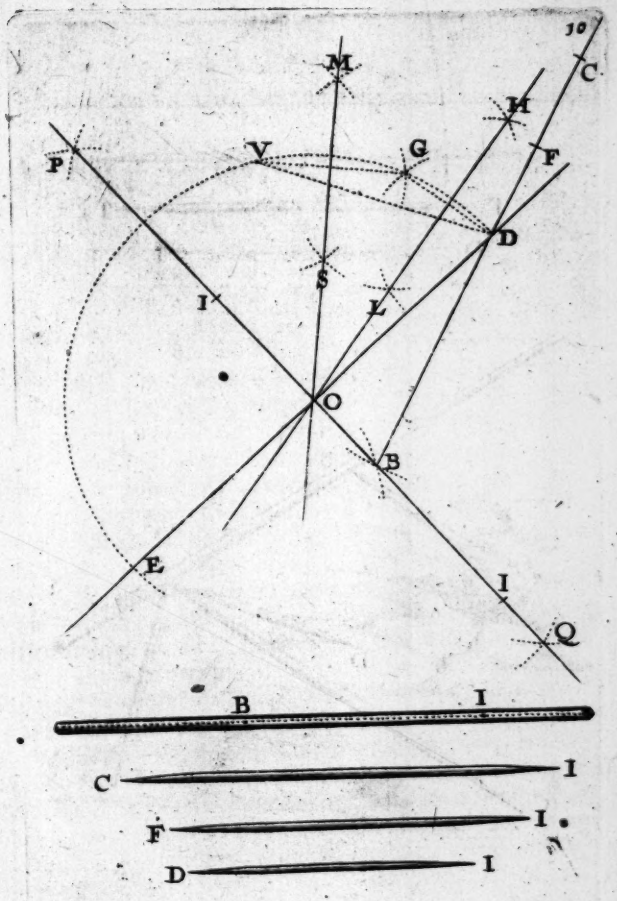
For in so doing, you have found in this figure below the distances that are from every one of the four points B D F C, to one and the same point I, that is to say the space from B to I, the space from D to I, the space from F to I, and the space from C to I, which distances B I, D I, F I, and C I, will serve you to place the Axeltree of the Dyal in the manner following.

Figure 10,

To all ſorts of People.

Cut (as you ſee in the lower figure,) three ſticks ſharp at both ends, one C I of the length of the point C, to the point I, otherwiſe of the ſpace C I of the figure above: The other F I, of the length of the ſpace F I of the higher figure, and take with your Compaſſes the ſpace B I of the figure above, and being ſo open, ſet both feet at once upon a ſtraight line, along the Axeltree rod of the lower figure, for example, in two points as B and I, and mark theſe two points B, I, in the Axeltree rod.

Fig.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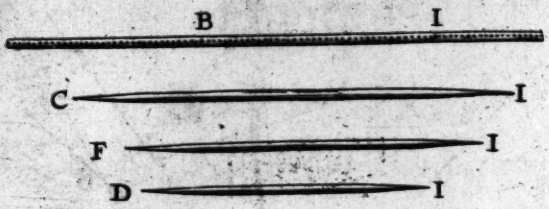
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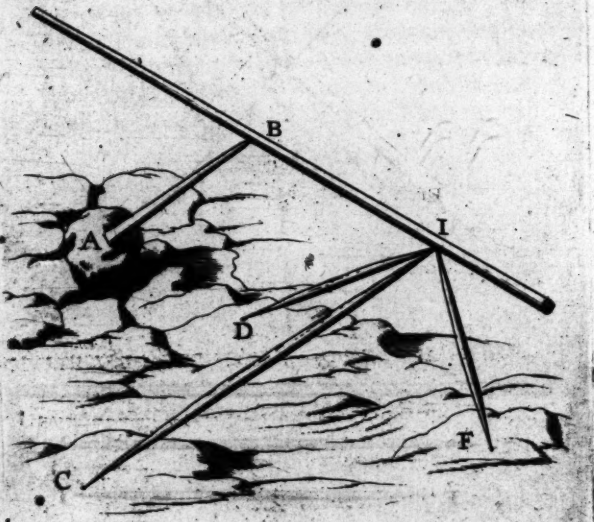
B
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Figure 11,

To all ſorts of People.

THat being done, go to the place of the Dyal, the which, to avoid the confuſion or multiplicity of lines, I have ſet below in the lower figure, ſet in this lower figure one of the ends of the ſtick C I, to the point of ſhadow C, one of the ends F, of the ſtick F I, to the point of ſhadow F, and one of the ends D, of the ſtick D I to the point of ſhadow D, and one of the points B of the Axeltree rod, ſet it to the point B, of the pin A B.

And holding thus the three ends C D F, of the three ſticks to the points of ſhadow C D F, every one reſpectively to his own, and the point B of the Axeltree rod, to the point of the pin B, bring together the three other ends I, of the three ſticks or rods C I, D I, F I, into one point in the air I, for they muſt meet there. then bring the point I of the Axeltree rod, alſo to the point in the air I, with the three ends I of the ſticks, for it muſt come and meet there exactly, if you have done right, or if the ſtraightneſſe of the place hath not hindered you.

If the ſtraightneſſe of the place of the Dyal hinders the three ends I, of the ſticks from meeting together in one point in the air I, take the point I in the figure below in the ninth cut, or that above in the tenth figure in an other place, than in that where you had taken it and according to the occaſion, then bring the ſticks to it as before (for you may take it any where, or in any place of the line P O Q, of one ſide or other of the point B;) but the further you can take it from the point B, will be better, and take it in ſo many places, that having ſet the ſticks of the points C D F, to this point I, and marked the ſpace B I upon the Axeltree rod, the four points I, may at laſt meet together in one point in the air I.

And when the point B of the Axeltree rod, is at the point

point B, of the pin A B. and when the three ends I, of the sticks, and the point I of the Axeltree rod are met, as you see in the lower figure, all four together in one and the same point in the air I.

The Axeltree rod will come then to be placed, just as it ought to be in the Dyal.

That if you do not care to be sure that your Dyal must be as just, as it is possible for art to do, in such a case, you may spare one of the four lengths C I, D I, F I, B I, and content your self with three only, as being sufficient for the Theorie; But the fourth will serve you for a proof, to see whether or no you have been very exact in working, and will justifie the three others.

Fig.

Figure 12,

To all sorts of People.

THe figure above shews you how that which you have done with three sticks, may be done either with many Compasses, with the help of some body, or else with other kinds of branches tyed or fastened one with another.

The same figure above, as also the figures below, shew how every one of those branches may be of two several pieces, which go in by couples into one hoop or ring, and slide along one by another, and are made fast with a screw to the measure where you will have them to stand upon, and these pieces may be made of tinn'd yron, or of yron, if you are afraid that their points will grow dull by often using them.

Or otherwise they shew you that instead of one stick, you may have two, both sharp at one end, which you shall fasten and bind together at the other end, of what length or measure you please.

The same figures do shew you also, that two divers branches, viz. C I, and F I, may be fastened together in the place where you will have them to stand together, with a presse and a screw to fasten them with.

The higher figure shews you besides, that you may fasten or bind with strings or threds, the Axeltree rod with the point B, of the pin A B, and the two branches C I, F I, with the Axeltree rod, to make them stand fast of themselves in their place.

When you have found thus the placing of the Axeltree rod, it is in your choice, either to seal it and fasten it in that place, or to place another instead of it, that may go the same way, and that may be every way equally distant from it; But that you may be the more exact, it will be as good to seal or fasten that in the place, where the practice of the Draught hath caused it to meet, than to place another, unlesse there was some occasion or necessity for it.

Fig.

B
A
I
D
C
E
C
F
G
G

Figure 3,

To those that have understood what hath been said before.

HAving understood what I have said before, concerning those many wayes of finding the position of the axeltree of the Dyal, you may compose others besides, making use partly of that of one figure, and partly of that of an other.

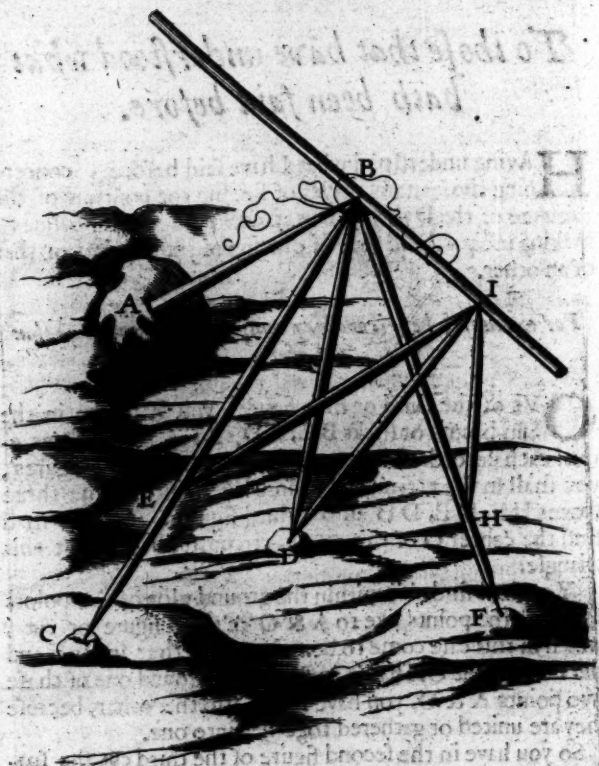
For example, here is one way composed of two of those that are afore.

OVt of the third or fifth figure, you shall take in the Sun-beams or sticks B C, B D, B F, three spaces equal each unto the other; And out of the 5 and 6 figures, you shall make a triangle of three lines equal to the three spaces H E, D E, D H of the third figure, and you shall find the center O of the circle, circumscribed about this triangle.

You shall find also within the ground plot of the points H D E, the points like to A & O of the 6 figure or cut, which in this case come to be united together in one and the same point O. That is to say, having found one of these two points A & O, you have found also the other, because they are united or gathered together into one.

So you have in the second figure of the third cut, the spaces D O, and D I, for two sides of a triangle with straight angles or corners O D I, whose side D I, holds up the straight angle, and the sides D O, and D I, do contain or comprehend it.

Make this triangle O D I, with three sticks, or with any other thing that may be strong and small as you will, so that you may at your need lengthen the side I O, from the right angle O.


B
A
I
H
C
F

Set the point D, of this triangle D I O, to the point of shadow D, and holding this point of triangle to this point of shadow D, make the side I O, of this triangle (drawn at length if need be) come and touch the point B, of the pin A B for if you have been very exact in working, it must touch it.

Take a stick H I, of the length of D I, set one of the ends to the point H, and bring the other end to the point I, of the triangle O D I, without the side I O, leave the end B of the pin A B, for it must be so, if you have wrought exactly as you ought.

You may have also an other stick E I, of the length D I, and set one end to the point E, and bring the other likewise to the point I, of the triangle D I O, without the side O I, leave the end B of the pin A B.

That being done the rod B I, comes to be the axeltree of the Dyal, and placed as it ought to be, and so of all the other wayes that you find besides.

You may, if you will make use of a triangle rectangular E O I. and of the stick H I, content your self only with the three equal lengths E I. D I, H I, to find out the point thereby, that you may draw from thence a line to the point B, without making use of any thing else to know if you have done exactly or no, you can not be sure whether you have done well or ill.

But when you have together with that, either a fourth length B I, or the straight angle D O I, that will serve you to try whether or no you have been exact in your operations, for as concerning an effectual execution, unless you have from time to time such a kind of proof, to shew whether you have wrought exactly as you ought, you cannot assure your self that your work is as well as it can be done.

One thing I must tell you, that in some certain occasions according to the times and the placing, or according as the superficies of your Dyal is, the shadow of the pin comes to be of such a length, and the extremity or end thereof so weakned, and so diminished in strength, and so confuse in the superficies of the Dyal, that it is very hard to find out

the extremity to mark a point in it.

That being so, I have not undertaken to shew you how to do impossibilities; but if you have understood well what I have said before, how little industrious and skilfull soever you may be, you may apply upon the superficies of your Dyal, something that you may take away afterwards and that may come to receive the shadow of the end B, of the pin A B, so fully, so clearly, and so fitly, that you may mark in it the points of shadow C D F, and make use of those points in the same manner as if they were in the superficies of the Dyal, till you have placed the axeltree; then take away that which you have layed, for the receiving of the shadow of the point of the pin A B.

This is such an easie thing to conceive, and to do, that I will not vouchsafe to present you the figure, nor to say any more: and I think I have said enough concerning the manner of placing the axeltreee, that I may speak hereafter of the wayes of finding the places, and tracing the lines of hours in the superficies of the Dyal.

B
A
C
F

Figure 13,

To all sorts of People.

I come now to the next and second thing that you are to do, which is to trace out the lines of the hours.

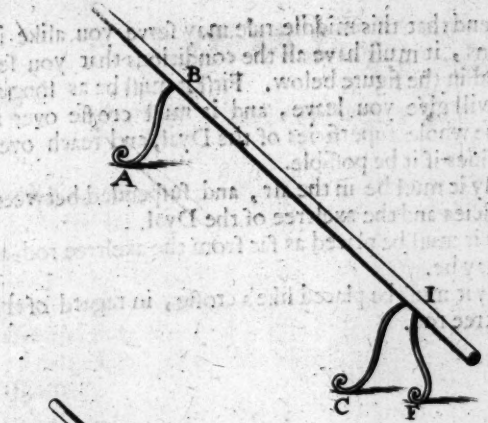
IN this example I suppose that the Axeltree rod doth not meet the superficies of the Dyal, about the place that you work in; and therefore I represent it suspended in the air, with two or three supporters as you see, I suppose also that the superficies of the Dyal is not smooth, but rough and uneven as I have said.

When you have placed the Rod B I, which is the Axeltree of the Dyal, as you see both in the higher and lower figure, you have made an end then of the first of those two things that you were to do, for the making of your Dyal: Now there remains but the second to be done, which is the finding and the tracing out of the lines of the hours in the Dyal; and for that purpose.

Consider in your higher figure, that the superficies and the axeltree of your Dyal are two divers things, and differing one from an other, and there is no such communication from the one to the other, as that with them alone you may find out directly the place of the lines of the hours, without making use of a third thing that may be a means betwixt those two.

The meanest and the least thing that you can have to be a means betwixt the superficies and the axeltree of the Dyal, is a Ruler.

You must have therefore besides the superficies and the axeltree of the Dyal, in some other place, at least a Ruler, as you see in the lower figure the rule P Q, which rule may be a means between this superficies and the axeltree of the Dyal, and that by means of this middle rule you may do so, that there may be such a communication as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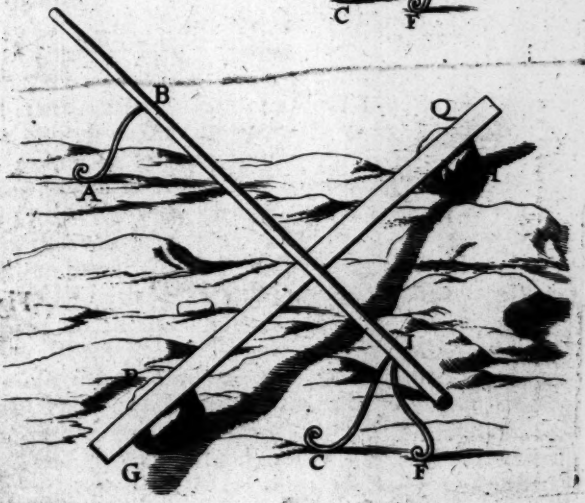
B
Q
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you please, from the superficies to the axeltree of the Dyal.

To the end that this middle rule may serve you alike in all occasions, it must have all the conditions that you see represented in the figure below. First it must be as long as the place will give you leave, and it must crosse over if need be the whole superficies of the Dyal, and reach over on both sides if it be possible.

Secondly it must be in the air, and suspended between the superficies and the axeltree of the Dyal.

Thirdly it must be placed as far from the axeltree rod, as possible may be.

Fourthly it must be placed like a crosse, in regard of the same axeltree rod.

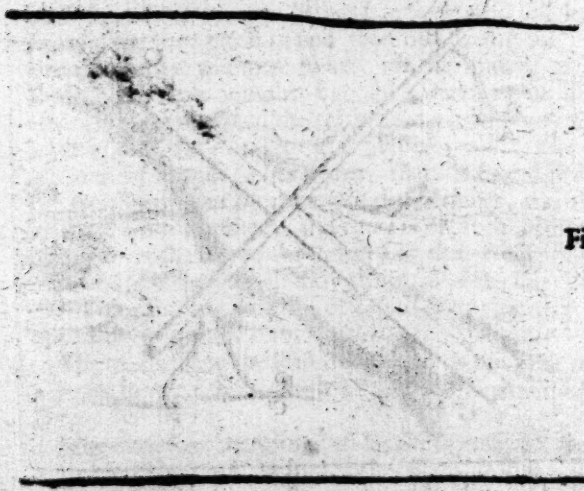


Fig.

Figure 14.

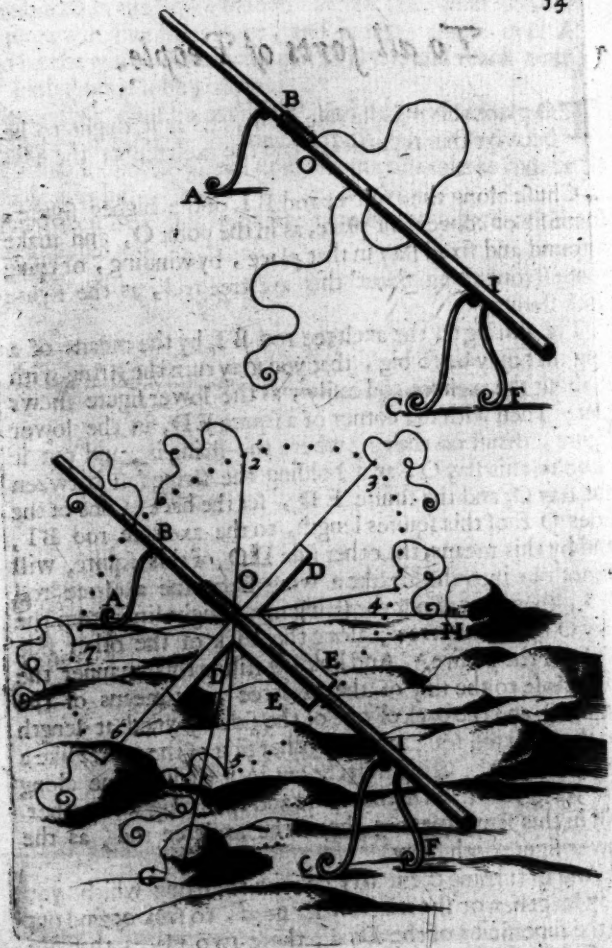
To all ſorts of People.

TO place this middle rule well, and as it ought to be betwixt the ſuperficies and the axeltree of the Dyal.

Chuſe along the axeltree rod B I, of the higher figure, ſome fit or convenient place, as in the point O, and make a round and fixed ſtay in that place, by winding, or tying ſome ſtrong thing about this axeltree rod, as the figure doth ſhew.

Tye a ſtring to the axeltree rod B I, by the means of a ring that may be ſo big, that you may turn the ſtring with it about the axeltree rod eaſily, as the lower figure ſhews you; Then with the corner of a ſquire E D, in the lower figure, thruſt on the ring where the ſtring is, and put it cloſe to this ſtay O, and holding the ſtring faſt between the ſtay O, and the ſquire E D, ſet the back of one of the ſides O E of this ſquires length, to the axeltree rod B I, and by this means, the other ſide D O, of this ſquire, will ſhoot out into the air like a wing from the axeltree rod B I, then ſtretch out the ſtring in a ſtraight line from the ſtay O of the axeltree, along the back of the other ſide O D of the ſquire. And holding ſtill in this manner the ring cloſe to the ſtay of the axeltree, by means of the ſquire, and the back of one of the ſides joyned at length to the axeltree rod, and the other ſide of the ſquire like a wing, and the ſtring ſtretcht out in a ſtraight line along this wing, turn both the ſquire and the ſtring altogether ſtill in this ſame manner about the axeltree rod, as the lower figure doth ſhew.

And in turning them ſo, go with the ſtring which you may lengthen or ſhorten at your need, to ſeek or find out in the ſuperficies of the Dyal, thoſe two places that are fartheſt one from another, in which this ſtring ſo ſtretcht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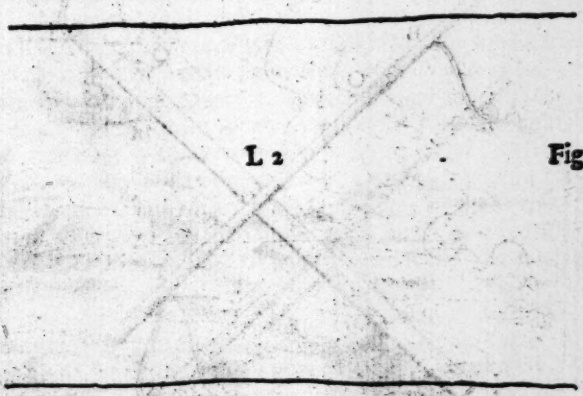
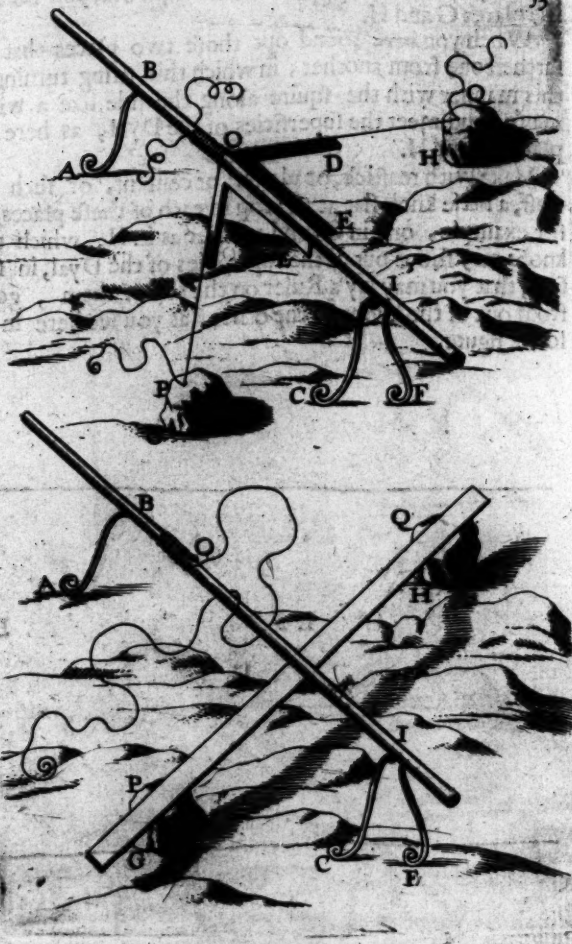
out may meet the ſuperficies of the Dyal, as you ſee here the places G and H.

When you have found out thoſe two places that are fartheſt one from another, in which this ſtring turning in this manner with the ſquire along the ſide like a wing, may go and meet the ſuperficies of the Dyal, as here the places G and H.

Make with maſtick, or plaſter, or cement, or ſuch like ſtuff, a little knob flat at the top in each of theſe places, as for example, one in G, and another as in H, which two knobs may ſhoot out of the ſuperficies of the Dyal, in ſuch ſort, that you may lay a Ruler on the top of them, going from one of the knobs to the other, as you ſee here in the lower figure.

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E

Figure 15,

To all ſorts of People.

WHen you have thus made thoſe two knobbs G, H, in the lower figure, take the ſquire again and the ſtring, and ſet them again cloſe to the ſtay O, of the axeltree rod, as you know they were.

And make them go about again as before, both together about the axeltree B I, and while you are turning about, the ſtring will fall right over againſt the two knobs, ſhorten or lengthen it ſo, that it may go and touch a point, at the top of each one of the two knobs, one after another; viz. a point as P, at the top of the knob G, and a point as Q, at the top of the knob H, and mark theſe two points Q and P, upon theſe two knobs.

When you have mark'd two points in this manner, ſet a Ruler in the lower figure upon theſe two knobs, and place it ſo, that it may paſſe from one to the other, by thoſe two points Q and P, and make the Ruler faſt in this place with cement or plaſter, or the like, in ſuch wiſe that it may not ſtir any way.

And this rule ſo placed, is the third and middle piece between the ſuperficies, and the axeltree of the Dyal, by means whereof you ſhall cauſe, as I ſhall ſay hereafter, this ſuperficies and this axeltree to have what communication ſoever you pleaſe one with another.

After you have placed this middle rule in this manner, between the ſuperficies and the axeltree of the Dyal.

Conſider that in *France* now they reckon 24 hours, for one day and a night, and that theſe 24 hours, are divided in twice twelve houts, and that every one of theſe 12 hours is ſubdivided in twice 6 hours.

So that in the 24 hours of one day and one night, as they are now reckoned in *France*, there are two hours that are each of them of 12, that is to ſay, one hour of 12 in the middeſt of the night, and another hour of twelve in the middeſt

middeſt of the day, theſe two hours of 12, are called midnight and midday, then there are two other hours, each of them of 6. viz. an hour of 6 in the evening, and another of 6 in the morning.

Where you muſt note, that both the two hours of 12, and the two hours of 6, come alwayes to meet together in one and the ſame line, though it may be lengthened if need be, viz. the two of twelve in one line, and the two of 6 in an other.

And you ſhall know, that it is an infallible thing, that within the Compaſſe of the ſuperficies of the Dyal where you work in, if you have placed the axeltree pretty near it, there muſt needs be either one of the hours of 12, or one of the hours of 6, and ſometimes they meet there both at once, that is to ſay, one of the hours of 12, and one of the hours of 6.

There be many ſituations of ſuperficies of Dyals, in which, within the Compaſſe, where one may trace in the hours, there is only the line of the hours of 12, and there is found not any one of the hours of 6, and others in which there is found only the line of the hours of 6, and not any one of the hours of 12. But there is no Dyal in which, within the Compaſſe where it is traced in, but the hours of 12, and any one of the hours of 6 are found in it, I mean that one may find in it, either one or other of the hours of 12, and of the hours of 6, by ſetting the axeltree near enough to the ſuperficies of the Dyal.

And now ſince you are ſure, that there is without doubt in your Dyal, either one of the hours of 12, or one of 6.

You ſhall begin to ſeek in it, firſt the place of that ſort of hours of twelve or of ſix, that may be in it.

And when you have found the point, either of one of the hours of ſix, or of one of twelve; You ſhall find afterwards the points of the other hours, that meet with it in the Dyal it is in your choice to begin to ſeek the point, of which of the two ſorts of hours of 6, or of 12, you will, and I will ſhew you two wayes of ſeeking them out, both one after another, that when they come to be both in the Dyal, you may find them out both there if you will, for

they

they ſerve for a proof one unto another, if you have been exact in your operation.

That you may finiſh your Dyal as you ought, ſeek in the middle rule the point which is there to be found, either of the hours of twelve, or of the hours of ſix, for it is ſet there on purpoſe to ſerve for that chiefly.

For example, ſeek out firſt in it the point of one of the hours of ſix, as I am going to ſhew, then I will ſhew you the way to find out the point of one of the hours of 12, and afterwards I will ſhew you the way to find out the points of all the other hours of the Day.

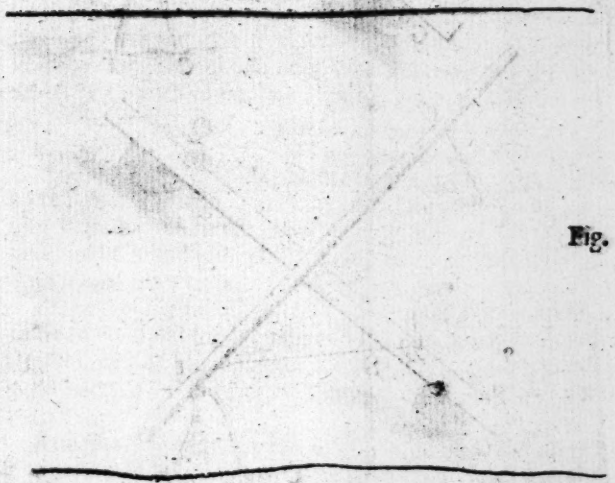

Fig.

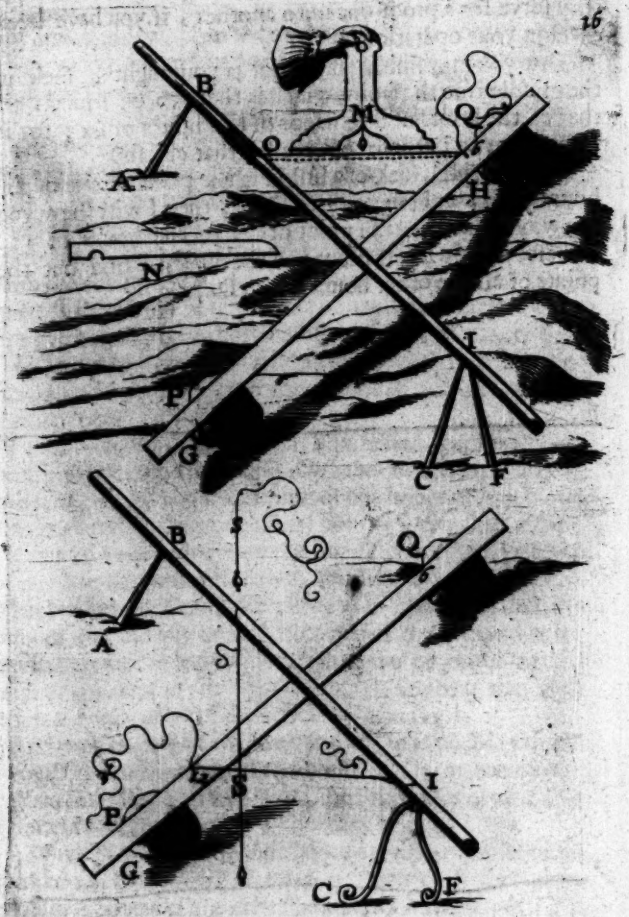
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Figure 16,

To all sorts of People.

TO seek out in the middle rule, whether the point of one of the hours of 6 be there.

Take the string that is made fast to the axeltree, set it very close again to the point or stay O, as it was when you made it turn about the axeltree, then stretch it out in a straight line from the point O of the stay of the axeltree, to the middle rule P Q, and holding still this string so stretcht out, make it turn about the point O, carrying it from one to the other of the points Q and P along the rule Q P, and making it longer or shorter if need be, and set a Carpenters level or triangle over it, to see, while it turns thus, stretch't out in a straight line about this point O, keeping along the middle rule, whether there is any place, wherein it comes to be found levell, as for example, you see in the higher figure (over the leaf) and when you find it to be level, you must make it fast there.

And that your level may be more fast, you may set it by the middle upon the axeltree rod close to the stay, or you may set close to the stay a ruler notch't at one end, as you see the ruler N, is notcht, then guide it with the string, And it will serve to fasten the level upon it.

Or to say it again otherwise, you must, as you know, cause to go about the axeltree rod the squire and the string stretcht out, as I have said, in a straight line, and made longer if need be, this string will go and passe all along the ruler P Q.

And if it happens that the string, so guided or carryed along the middle rule P Q, come to be found level, as the higher figure shews, mark in this middle rule the point 6, where this string toucheth or reacheth unto, when it is so level, and remember that this point 6, is the point of one of the hours of 6, either of the evening, or of the mor-

ning. This is that which concerns one point of one of the hours of 6, that if the string in turning thus, comes to passe from one end of the middle rule to the other, without falling to be level it is a sign, that not one of the hours of 6, comes to be found in this Dyal, so frame it from the point that you have taken for a rest or stay.

Now that you may seek out the point of the hours of 12, in the lower figure.

Fasten the center of a hanging plummet, with a string S, to the middle of the body of the axeltree rod, above it or under, as the lower figure shews, it matters not, and as the occasion will permit or require, and set this plummet so, that it may come and fall as near the middle rule as you can.

Then tye to the axeltree rod, as far as you can from the superficies of the Dyal, another string I with a loose knot, and when the plummet of the first string S, comes to be at rest, make it so fast that it may not stir, then stretch out this second string I in a straight line, in such sort, that comming from the axeltree rod, it may go and touch the string of the hanging plummet S, without breaking (or stirring) the string nor the lead, and so holding this second string I, stretcht out close to the string with the plummet on S, see whether this second string stretcht out in this manner can, being made shorter or longer, if need be, go and meet the middle rule, in a point, or not.

And when this second string so stretch'd out comes to meet the middle rule, in one point, as 12, mark in the middle rule this point 12, in which this string so stretcht out doth meet with it, and note that that point 12, is the point of one of the hours of 12.

When you have found out and markt in the middle rule the point of one or other of the hours, either of 6, as you see in the figure above, or of 12, as you see in the figure below, if you have them both, they shall serve for a proof one to another, if you have but one, you may make use of that alone.

Let us suppose first, that it is the point of one of the hours of 6, as the point 6 in the Dyal; you shall go on in finding out the points of the other hours, which may be found in your Dyal, in this manner following.

Figure 17.

To all Sorts of People.

MArk at your diſcretion in the rule P Q, two ſeveral points M N, and conſider the point in the middle of the body of the axeltree, cloſe by the ſtay O, that is the Point about which you have turned the ſtring with the corner of the ſquire. You ſee there three ſeveral points unmoveable, and fixed, viz. the point M, and the point N, in the middle rule, and the point O, in the middle of the body of the axeltree rod, cloſe to the ſtay. And ſo having thoſe three points fixed, M, N, O, you have by this means the three ſeveral diſtances, viz. the meaſures of the diſtances that are from one of theſe three points, to the two others, viz. the ſpace or diſtance from the point M, to the point N, the diſtance from the point M to the point O, and the ſpace from the point N, to the point O.

Remember two things, one is, that the point O, is in the middle of the body, that is to ſay of the bigneſſe, and not in the out ſide of the axeltree rod. The other is, that theſe two points M N, that you have mark'd at diſcretion in the middle rule, are not for all that certainly the points of hour, and that they are to ſerve you to find out the points of hour, and perhaps they may chance to be ſome of them; and may be not, and perhaps you muſt blot them out after you have found out the points of hour.

This being done ſo, take with your Compaſſe upon the middle rule, the diſtance from the point M, to the point N, and with this ſpace go to ſome place that is flat or ſmooth, and ſet both the feet of your Compaſſe therein at once, as in the figure below in the points M and N, and by theſe two points, draw a ſtraight line M N, as long at either end as the rule P Q.

Then go back to the Dyal above, take with the Compaſſe the diſtance which is from the poſnt M, to the mid-

dle

dle of the bigneſs of the axeltree cloſe by the ſtay O, or elſe otherwiſe, take the diſtance which is from the point M, to the axeltree towards the ſtay O, and adde unto it half of the bigneſs of the Axeltree; and with this ſpace M O, come back to the figure below, ſet one of the feet of the Compaſſe to the point M, and turning this foot about upon this point M, trace with the other foot a line crooked like a bow O, go back to the figure above, take again with your Compaſs the diſtance which is from the point N, to the middle of the bigneſs of the axeltree cloſe by the ſtay O, and with this ſpace come back to the lower figure, ſet one of the feet of the Compaſs to the point N, and turning this foot upon this point N, trace with the other foot another crooked line that may meet with the other in one point, as O, for it muſt meet with it.

Then open your Compaſs at diſcretion, rather more than leſſe, and ſet one of the feet of the Compaſs ſo open at diſcretion to the point O, and turning this foot of the Compaſs upon this point O, trace with the other foot a round R G S H. Go back to the Dyal in the figure above, take with your Compaſs upon the rule Q P, the diſtance which is from one of the points M or N, to the point of 6 hours, and with this ſpace, for example of M 6, come back to the lower figure, ſet one of the points or feet of the Compaſs upon this point M, go and mark with the other foot in the line M, a point as 6, of the ſame ſide upon the rule.

And ſo you have in the line M N, one and the ſame thing as you have in the Dyal in the middle rule, viz. the three points M N and 6, of the ſame diſtance, in each of theſe two ſtraight lines.

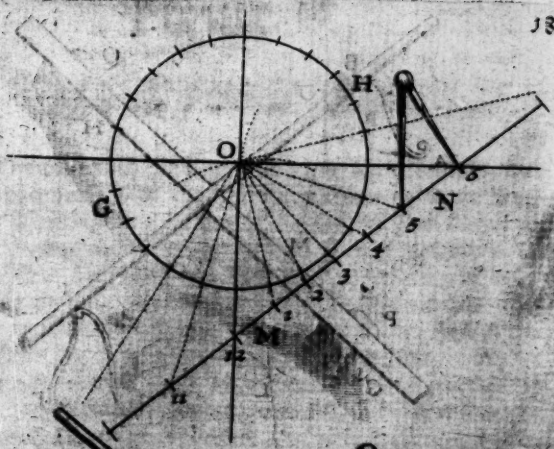
This being done, draw in the figure below by the two points O and 6, a ſtraight line O, 6, which may divide the round R G S H, in two halfs R G S, and R H S.

Open the Compaſs at your diſcretion, and as much as the ſpace will give you leave, and keeping your Compaſs ſo open at diſcretion, ſet one of the feet to the point S, and turning this foot upon this point S, trace with the ō-

ther

ther foot, two crooked lines L and D, then with the same space, remove your Compass out of his place, and set one of the feet to the point R, and turning this foot about upon this point R, trace with the other foot two other crooked lines, that may meet in two points L and D, the two crooked lines that you have drawn about the point S, and mark those two points L and D, and draw by those two points a straight line L D, which may passe by the point O, if you have been exact in your operations.

So you have divided this round, into four quarters of a round, with the two straight lines S O R, L O D, and if the straight line L O D, drawn in length comes to meet the line M N, in a point as 12, it shews that there is also the point of the hours of 12, in your Dyal, viz, in the middle rule between the superficies and the axeltree; now divide with your Compass every one of these quarters of the round, into six parts equal, as you see in the points that are upon the brim of the round R G S H, and by the center or middle point of this round O, and by every one of the points of these divisions of the edge or brim of the round, draw some lines or beams, as you see some drawn already, that may go and meet the straight line M N, as in the points, 5, 4, 3, 2, 1, 11. and these points are the points of the other hours, that are to be found in your Dyal.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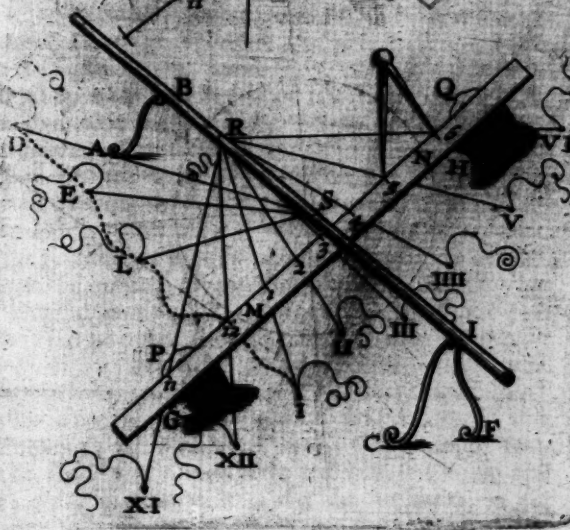
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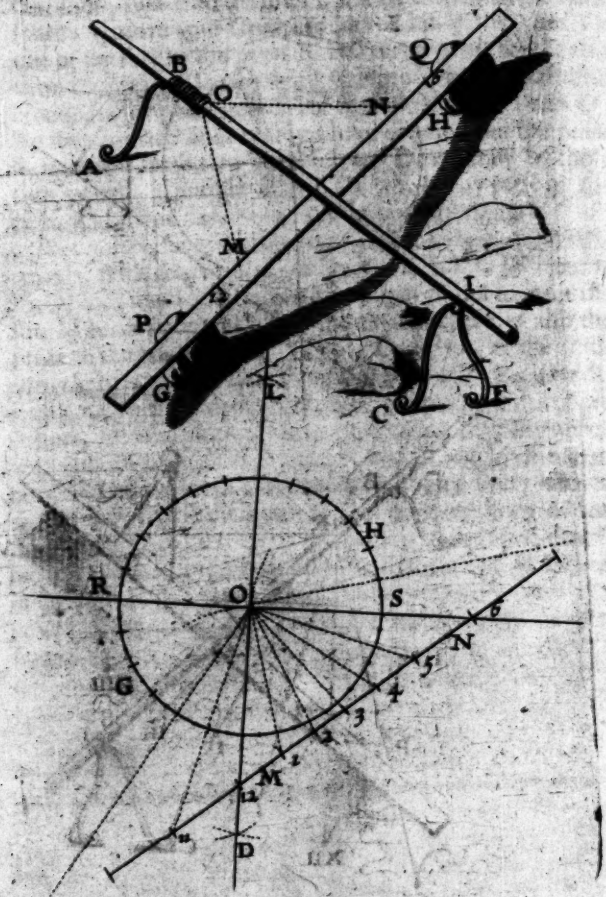
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Figure 18,

To all ſorts of People.

NOw take with the Compaſs in the figure above, the ſpace from 6 to 5, and with this ſpace go to the Dyal in the figure below, ſet one of the feet of the Compaſs to the point 6, and keeping this foot of the Compaſs upon this point 6, go and mark with the other foot in the middle rule another point 5, and by this means you ſhall tranſport with your Compaſs the ſpace 6, 5, from the line of the figure above, which repreſents your table, or the flat place in the Dyal of the figure below, upon the middle rule M N, & ſo accordingly take with your Compaſs every one of the other ſpaces, 5, 4, 4, 3, 3, 2, 2, 1, 1, 0, 2, 1, from the higher figure, and bring them in this manner to the Dyal upon the middle rule, in the lower figure, and ſo you have done in this middle rule in the Dyal of the lower figure, all and the ſame ſpaces as thoſe are, that are upon the table of the lower figure: And thoſe points of the middle rule of the lower figure, are as many points of hours that will be in the Dyal, among which you know that the point 6, is the point of one of the hours of ſix, either of the evening, or of the morning, whereby you ſhall come to know which are the other hours, whereof you have the points ſo mark'd in the rule of the Dyal.

As for to let you know, whether this point of 6 hours, is either of thoſe in the morning, or of thoſe of the evening, I will not trouble this paper with it, becauſe that is plain enough of it ſelf: And you ſee well enough, whether the ſhadow of the axeltree rod will fall upon this point, either in the morning about the beginning of the day, or elſe in the evening about the ſhutting up of the day. By this means you may ſee well enough, whether the hours of your Dyal are of thoſe of the forenoon, or of the afternoon, for to mark them accordingly, without

ſpeaking

speaking any further about it. If you have found upon the middle rule M N, the point of one of the two hours of 12, and not the point of one of the hours of 6, you are but to do with that point of hour of twelve, the same thing that I said you should do with the point of one of the hours of 6.

When you have so transported the points of the hours from the Table of the figure above, to the Dyal in the lower figure upon the middle rule: That which remains to do, is to transport those points of hours from the middle rule, into the superficies of the Dyal in the manner following, and to trace in it afterwards the line of the hours, as I will shew you.

You see, there are two strings tyed to the axeltree rod, in the figure below, set the rings of these two strings, as far as you can one from another, and as from R in S, then take one of these two strings, as that which comes from the point R, carry it stretcht out in a direct line from the axeltree rod, to one of the points of hours that are mark'd in the middle rule, for example in the point of hour 12, and cause this string comming so from the axeltree, to passe to this point of hour 12, of the middle rule, and to go altogether in a straight line as far as the superficies of the Dyal; and mark in the superficies of the Dyal the point in which this string so carryed, meets it: By this means you shall transport this point of hour 12, from the middle rule into the superficies of the Dyal to the point XII.

And after the same manner, you shall transport one after another the points of hour 11, 12. 1, 2, 3, 4, 5, 6, from the middle rule, into the superficies of the Dyal to the points XI, XII, I, II, III, IV, V, VI.

Fig.

Figure 19,

To all ſorts of People.

How to trace the lines of the hours upon the ſuperficies of the Dyal.

OF the two ſtrings, fig. above, that are made faſt to the axeltree rod, ſtretch out one in a ſtraight line, from the axeltree rod, as from the point R to a Point of hour of the middle rule, as to the point of hour I., and holding this ſtring ſo ſtretcht, take the other or ſecond ſtring comming from the point S, and ſtretching it likewiſe in a ſtraight line, make it croſſe over the firſt ſtring BI, and let it touch it without breaking his ſtraight line, and let it go in a ſtraight line from thence, to the ſuperficies of the Dyal as to the point D, and mark the point D, in the ſuperficies of the Dyal, wherein this ſecond ſtring ſo carried, comes to touch it; then make this ſecond ſtring to go and touch again the firſt in another place, and with this ſecond ſtring go and touch in the ſame manner, another point E, in the ſuperficies of the Dyal E, And ſo remove this ſecond ſtring along the firſt ſtring, as many times as you ſhall have need to mark any ſeveral points, as D, E, L, in the ſuperficies of the Dyal, to trace the line of that hour there, then draw a line as fine and delicate as you can by all thoſe points D E L, in the ſuperficies of the Dyal, that line ſhall be the line of that hour I.

And after this manner, you ſhall trace in the ſuperficies of the Dyal, the lines of all the other hours that are in the middle rule, and your Dyal will be finiſhed.

The lower figure ſhews you to the eye, how that after you have tranſported as above ſaid, all the points of hour from the middle rule into the ſuperficies of the Dyal, you may take away this middle rule, and the two knobs that

hold it up, and make an end of tracing the rest of the lines in the superficies of the Dyal, as I have said, with the strings comming from R and I, and by means of the points of hours XI, XII, I, II, III, IV, V, VI.

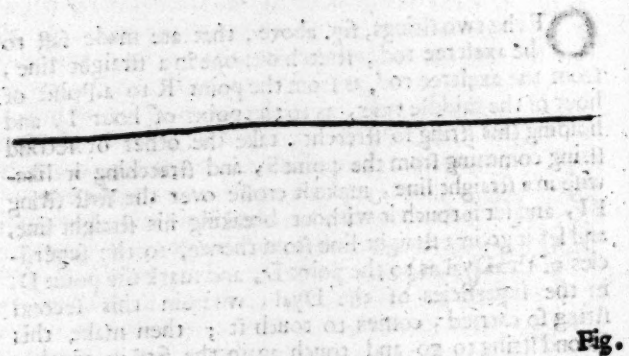


Fig.

Figure 20,

To all ſorts of People.

AFter that you have placed the axeltree of the Dyal as it muſt be, if you deſire to find the points of the hours in the ſuperficies, with ſome extraordinary inſtruments, that which is the plaineſt of all, viz. a round flat plate, and ſtiff, as of tinn'd yron, or the like, and divided into 24 parts equal one unto another, and ſet up in the manner of a rotunda or whirl, by the ſquire, or with right angles about the axeltree of the Dyal, as the figure below doth ſhew, is the moſt common and the ſhorteſt way of all.

The figure H, ſhews you this round alone, and how it is open of one ſide, that the center thereof may be placed with the center of the axeltree.

The 1. figure ſhews the neck that may be applyed unto this round about the center, to the end that one may with this neck, ſet the round to the axeltree of the Dyal by the ſquire, or with angles ſtraight between themſelves, as you ſee in the ſecond figure.

When you have thus ſet this round to the axeltree of the Dyal, the lower figure ſhews you how you muſt place the ſtring of the plummet, hanging upon the axeltree by a point of one of the diviſions of the edge of this round, that it may give you the points of the hours in the ſuperficies of the Dyal.

The ſtrings which comming from the axeltree paſſe afterwards to the points of the diviſion of this round in it's 24 parts, ſhew you, how you muſt afterwards bring the ſtrings from the axeltre, by the points of the diviſion of this round in 24 parts, equal to the ſuperficies of the Dyal, that you may have the points of the hours in this ſuperficies.

The ſtring L S, XII, that paſſeth to the ſtring with the plummet R S, gives the point of the hours of 12. The

string L VI, that passeth to one of the points of this division in 24, and is found to be level, gives the point of the hours of 6.

The other strings shew you, that the way of tracing the points of the other hours is the same as above.

Fig

Fig I.

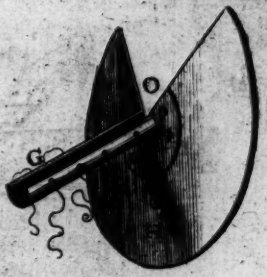


Fig II.

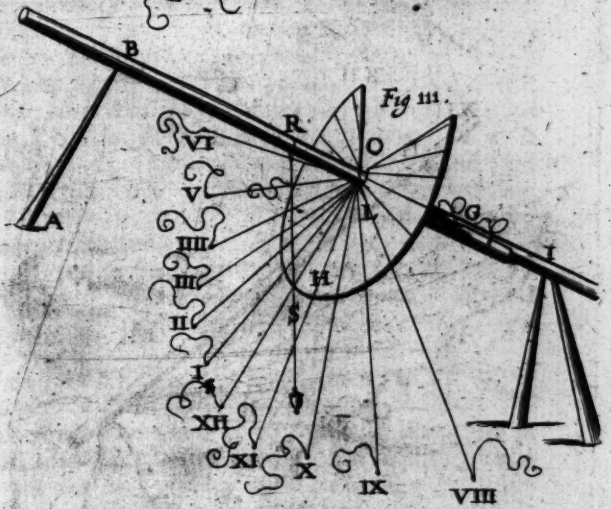


Fig III.

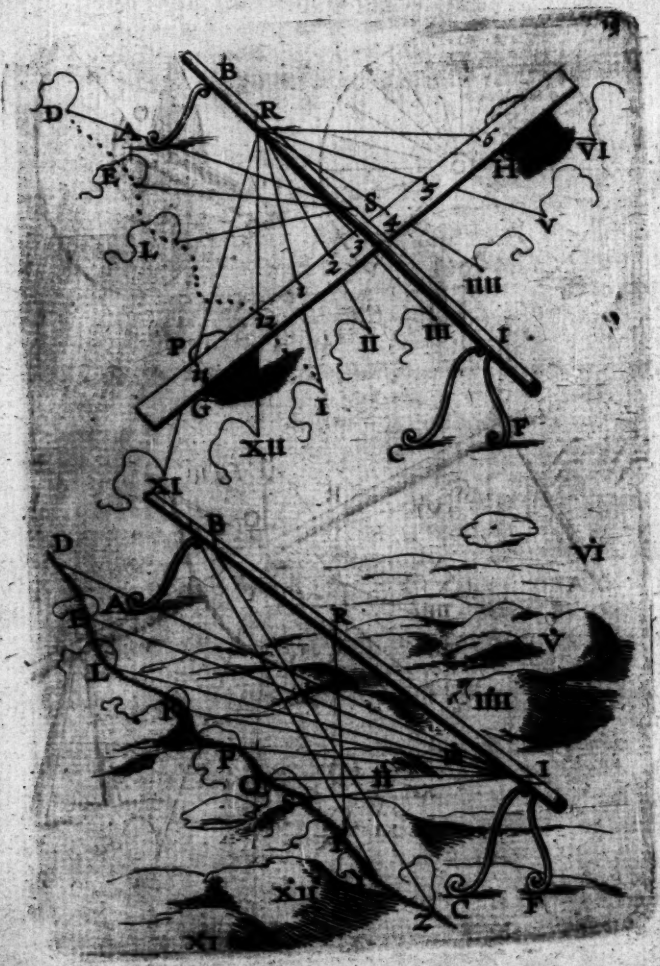

B
R
D
A
E
L
S
H
VI
V
IIII
III
II
I
P
G
XII
XI
C
F
B
D
A
R
L
P
Q
II
I
XII
XI
C
F

Figure 21,

To all ſorts of People.

WHen you have brought, as I have ſaid, by means of this rotunda and the ſtrings, all the points of the hours, into the ſuperficies of the Dyal; You may take away the rotunda if you will, and make an end of tracing the lines of the hours as before with the ſtrings, and by means of the points of hours, which you have brought into the ſuperficies of the Dyal, as you ſee in the figure below, the line D E L K P Q S Y I Z G.

And for this purpoſe by means of the ſaid ſtrings, carry a ſtring in a ſtraight line from the axeltree to the point of hour, for example I, and holding it there ſtretcht in a ſtraight line, carry of one ſide or other according to the occaſion, an other ſtring comming alſo from the axeltree, as from I, or from B, that may go in a ſtraight line as far as the ſuperficies of the Dyal, and let it go and touch, and croſſe over the ſtring I R, ſeveral times in ſeveral places, and at every time go with this ſecond ſtring to touch and mark a point in the ſuperficies of the Dyal, until you have enough, as you ſee the points D, E, L, K, P, Q, Y, I, Z, G, and carry by theſe points a line ſweetned, that ſhall be a line of hour, do the like for the lines of the other hours, and you have done.

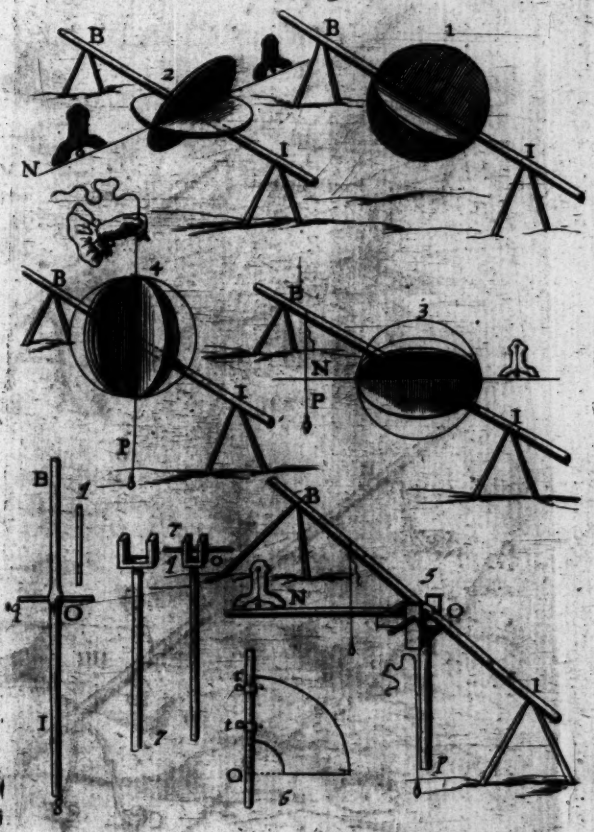
When you have mark'd in the ſuperficies of the Dyal, a point of every one of the hours that are to be found in it: If you deſire to trace the lines of the hours every one at once, without making uſe of the ſtrings, as in the figure above, you may do it when it is dark, as by night, with the light of a candle, in that manner as it is expreſt in the lower figure.

Set a light behind the axeltree rod of the Dyal, and turn the ſame light about this axeltree, untill the ſhadow of this axeltree come to one of the points of hour I, and

trace

trace in the superficies of the Dyal a line D E L K P Q S Y I Z G, all along the shadow of the axeltree, that line shall be a line of hour, do the like for every one of the other points of hour, and you have finish'd your Dyal.

Fig.


B
2
N
I
B
1
I
B
4
I
P
B
3
N
P
I
B
1
O
I
7
7
B
N
5
O
I
P
O
6

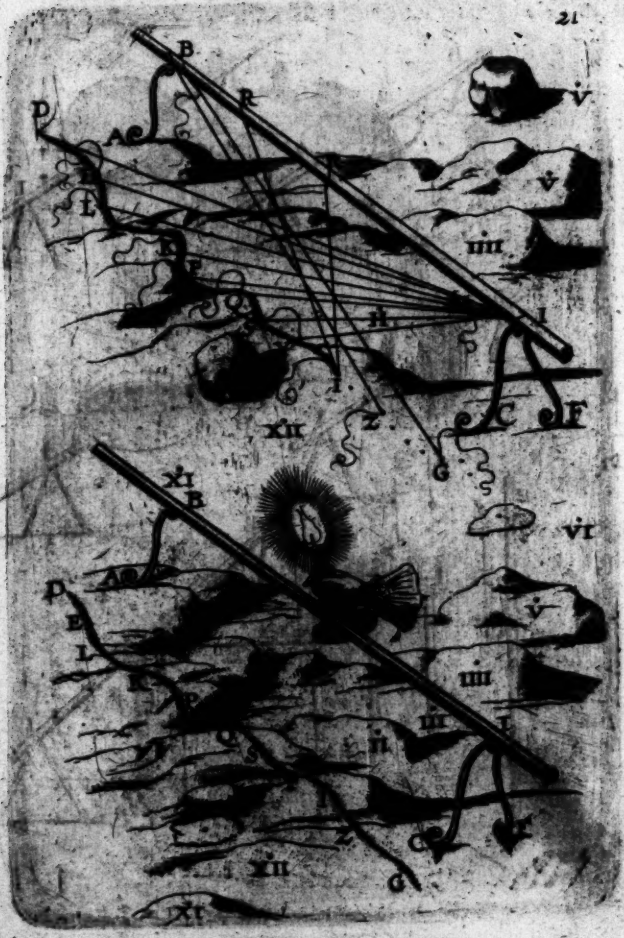

B
R
D
A
L
V
V
IIII
H
I
C
F
XII
Z
G
XI
B
VI
D
E
L
V
IIII
III
I
II
Z
C
F
XII
G
XI

Figure 22,

Several Instruments to work withall in these occasions hereafter specified.

I Did not intend to burden my memory with any thing in this matter, but with *Monsieur de Sarigues* universal rules for the placing of the axeltree, and for the tracing in a Dyal the hours after the French way, without medling with the rest, which is more curious than useful.

But to follow the advice of many considerable persons whom I do honour, I have set down also the way to mark that which is commonly called the signs: The hours after the Italian or Babylonian way: The hours after the manner of the Ancients: The elevations of the Sun above the Horizon; and the rising of the same.

And for as much as none can do any of these things universally, without using these instruments more or lesse; This table following shews to the eye all the pieces that are used in those several occasions. These instruments are first a circle, a half circle, or the quarter of a circle, which is all one, which is made to turn about its Diameter set fast in it's due and convenient place, or down right, as in the fourth figure, or level, as in the second or third figure, or else inclining or hanging downward, as in the first figure.

The way to make this circle to move in all kinds of positions, is to set two rings in it's Diameter, through which one may put in a stick straight, round, and smooth, about which this circle may turn round like a weather cock about his needle or spear, as in the second figure, and there must be within those hoop rings, a screw to fasten this circle in that place, or which way soever you will have it to stand.

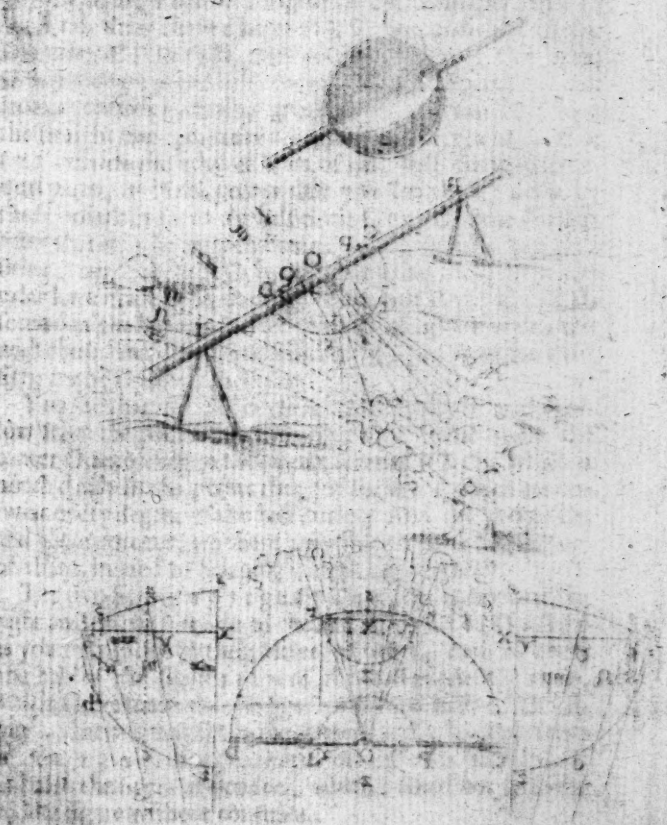
The sticks or rods are represented by the 7th. figure, with a fork at the end of every one, bored in the cheek, to put a pin through, as you see, that one may be set plum or down right, and the other level, being made fast at one

end

end to the axeltree rod as in the 5th. figure. And for this purpose also the axeltree rod is bored in O.

The 8th. figure shews the axeltree rod by it self bored with O, and the pin Q, put through the hole to shew more plainly than which the 5th. figure represents, viz. all the pieces set or joyned together being mark'd with q o.

You see that the hoop rings are near the edge or brim of the circle, a purpose to leave the center O, and a space about it free, having commonly a piece taken off, that this circle may turn freely about the forked end, that is to say about his center, without any let or hinderance at all.



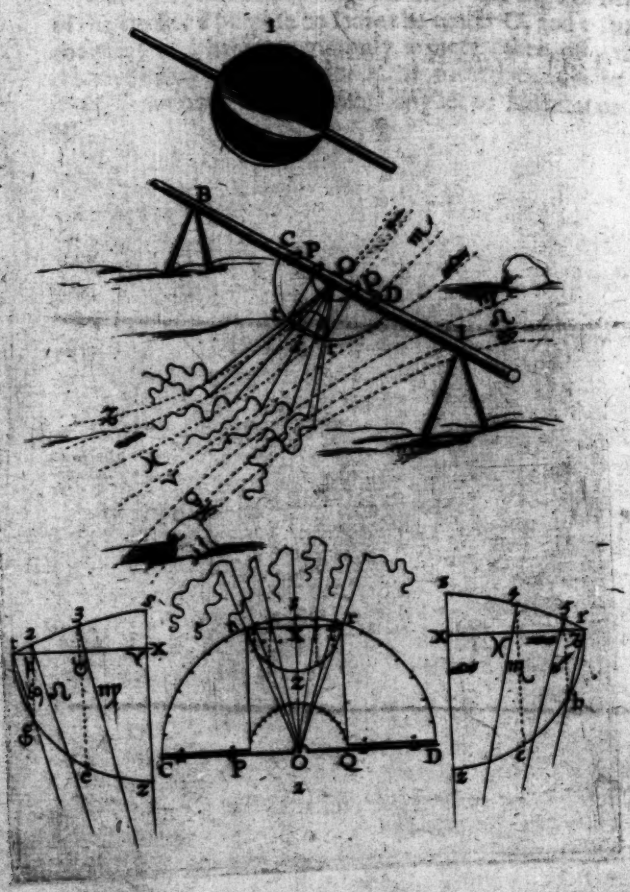

1
B
C
P
O
Q
D
X
Y
Z
C
P
O
Q
D
2

Figure 23,

How to mark the Signs.

GEt, figure 2 below, a half circle both thin and ſtiff c t s r d, draw there a beam O Z S, perpendicular to the Diameter C P O Q D, take on both ſides of this beam O S, 23 degrees and half; for example 23 degrees and half from s towards t, and as much from s towards r, draw the ſtraight line r, t, make upon Diameter t, r, a half, circle t z r, divide the edge or brim of that half circle in ſix equal parts, as in the points that you ſee there; draw by thoſe points as far as the half circle C t s r U, ſome ſtraight lines that may be perpendicular to the ſtraight line r, t, bring from the center O, by the points that thoſe perpendicular have made upon the edge of the half circle C t s r D, ſome ſtraight lines, as you ſee that the ſtrings ſhew you, and with thoſe lines drawn out ſufficiently, you ſhall mark the ſigns in the Dyal, as I ſhall ſay.

You ſee that the half circle is cut thorow, or made hollow from the point P, to the point Q, round about the center O, according to the circumference P Z Q; which is notch'd alſo in the points that you ſee in it, which are betwixt every degree of the half circle; And the center O, and theſe notches, are there a purpoſe to faſten a ſtring upon them, inſteed of bringing it from the center O.

The two figures s 3 2 r g e z, s 4 5 r b c z, both on the right and on the left ſide of the half circle C t s r D, ſhew as you may judge by their letters or coats, each of them one half of the figure t s r z, of the half circle C t s r D, which I have made thus bigger than each half of this figure, that one may ſet in the letters g e, c b, and ſome figures, 2 3 4 5, about the edges of the two half circles, and alſo the ſigns, as you ſee, which I could not do in the middle figure without confuſion.

The lines comming from the points t 2 3 s, s 4 5 r,

towards the loweſt part of the figure or plate, comming near one an other, go and ſeek the center of the half circle t 2 3 s 4 5 r. Every one of the three ſpaces between thoſe ſtraight lines is to hold two ſignes, mark them there in the ſame order that you ſee them, cloſe by theſe ſtraight lines, one of one ſide, and an other on th'other ſide.

And by this meanes the ſtraight line of the half circle t 2 3 s 4 5 r, which from the center of the half circle paſſeth to the points, is that of the ſignes of Aries, and of Libra; that which paſſeth to the point 3, is that of Taurus, and of Virgo; that which paſſeth to the point 2, is that of Gemini, or the Twinnes, and of Leo; that which paſſeth to the point t, is that of Cancer; that which paſſeth to the point r, is that of Capricornus; that which paſſeth to the point 5, is that of Sagittarius and Aquarius; that which paſſeth to the point 4, is that of the Scorpion, and of the Fiſhes.

The two figures s 3 2 c g e z, s 4 5 r b c z, ſhew you alſo that with one quarter of circle mark'd on both ſides with 6 ſignes in one part, and 6 others in the other part, you may do the ſame thing as well as with the half circle, by turning this quarter of circle, as you ſee in the ſaid figures, once of one ſide, and once of th'other.

I ſhall for all that ſpeak to you alwayes as if you had the half circle in your hand.

Therefore when you will mark the lines of the ſignes in the Superficies of the Dyall, The firſt figure ſhewes you how you muſt ſet up your half circle with the axeltree, for to turn it about the ſame, without going up or down along the axeltree.

The firſt figure above ſhewes how you muſt make your half circle, *viz.* about the axeltree, ſet then the half circle to the axeltree of the Dyall, as you ſee in the figure that is under the firſt.

Tye a ſtring with a looſe knot, juſt in the center of the circle.

Turn the half circle about the axeltree, cauſe at the ſame

same time the string comming from the center, to passe by one of the lines of the signes, holding it longer or shorter as need shall require, go and touch with the string many several points in the superficies of the Dyall one after an other.

Draw a line sweetned, by all those points, and it is the line of the signes that are markt along the straight line of the half circle which the string doth cover, in turning with it about the axeltree.

Do the like for every line of the signes, mark the signes in the Dyall by the lines so drawn according to the situation, in regard of the Country and of the place of the Dyall, and as the figure shews, you have marked the signes in the Dyall.

And if the strings could not come from the center, fasten them with a knot to the beames, comming from the center, in the notches or clefts of the circumference P Z Q.

Set a button or an other mark in the axeltree, in the place where the center of the half circle C t s r D hath been, and the shadow of the button will go and mark the signe that the Sun is in.

Figure 24.

To mark the houres after the Italian or Babylonian way.

THE first figure shews how you must set on your half circle, and how to make it turn about the axeltree.

Moreover, the line NO shews you what kind of lines comming from the center O of this half circle, you must make use of, in making the half circle to turn about.

When you have drawn the lines of the houres after the French way at length, in the superficies of the Dyall, as the figure below doth shew.

Set on, as the same figure shewes you also, the half circle O t r to the exeltree of the Dyall with a string ON in it's center.

Let this half circle hang down right or Plum, and when this half circle is just down and at rest, draw the string ON, in a straight line comming from the center O, and closing with the half circle, in such sort as it may go, and touch it all at length, turn this string as a beam of the half circle about the center O, till it be very levell, as the figure shewes by the setting on of the Carpenters levell A.

When the string ON is stretcht out very levell close to the half circle, mark exactly upon the edge of this half circle, the point wherein the string ON toucheth it, as doth the letter E.

Then let the half circle turn about the axeltree.

Make in the mean time the string ON, to passe by the point t, which you have markt upon the edge of the half circle, and making it shorter or longer according as need shall require, go and touch with this string many several points

points one after an other in the ſuperficies of the Dyall in divers places, 1, 2, 3, 4, 5, 6.

Draw an obſcure line by thoſe points, as you ſee the line bowed or crooked, 23, 24, 1, 2, 3, 4, 5, 6, and which reacheth beyond the axeltree towards h.

This line croſſeth over the ſuperficies of the Dyall, out of the Equinoctial line P Q, and meets by the way all the lines of the houres after the French way, as you ſee it doth in 23, 24, 1, 2, 3, 4, 5, 6.

There Remaines to trace the lines of theſe houres after the Italian or Babylonian way in the ſuperficies of the Dyall and when you know how to trace one, you ſhall be able alſo to trace the other.

Therefore to trace a line of thoſe kinds of houres, It is no matter which you begin to trace firſt; Count upon the Equinoctiall line P Q ſix paces of houres equall, after the French way, one after an other, as from XII. to VI. Afterwards follow the lines of the houres, after the French way, that paſſe by the points XII. & VI the two extremities of theſe ſix paces every one to the aforeſaid line of which you have found the place, by turning the ſtring with the half circle about the axeltree by the point t, as you ſee, as farre as the points 24. And 6.

Take conveniently in theſe two lines of hours after the French way, In each of them one of the points wherein it meets with the Equinoctial line P Q, or elſe the ſaid line found with the ſtring 1, 2, 3, 4, 5, 6, that is to ſay in one, the point that the line placed with the ſtring makes in it, and in the other; the point that the Equinoctial line makes in it, for example, In the line, XII, 24, take in it the point 24. Wherein it meets with the line found with the ſtring: and in the other, VI, take in it the point VI. wherein it meets with the Equinoctiall line.

Set either a ſtring or a rule by theſe two points ſo taken 24. and VI, as you ſee the line, 24. 6.

Then with the ſtring comming from the center of the half circle Q go razing or laying even the ſtring 24. VI by making it longer or ſhorter as need requires; as you ſee in O, g, mark many ſeveral points in the ſuperficies of the

Dyall

Dyall one after an other, as for example 24, g, VI, more or leſſe, according as the ſuperficies of the Dyall is more or leſſe uneven.

Draw an obſcure line by the points 24, g, VI, and it will be a line of houres after the Italian or Babylonian way, and ſo of all the reſt.

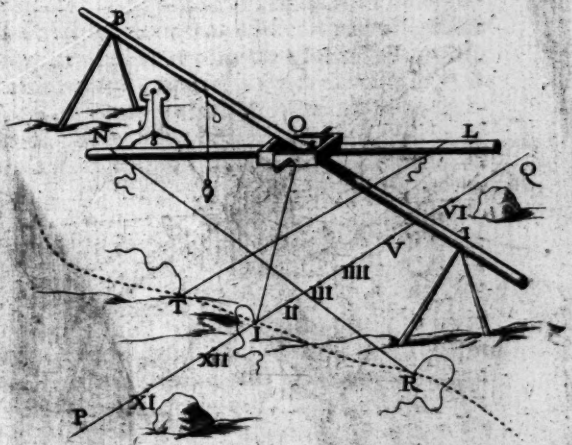
The ſtring h, OH ſhews that you may if need be, do the like both of one and of the other ſide of the centre O, to go and place of one part of other according to the occaſion, the line, as 2, 3, 4, 5.

And if you have a ſtraight line, as might be O, q, which may turn about the center O, and be perpendicular to the Axeltree BI, and you hold the half circle with this ſtraight line, ſet one at a convenient or reaſonable diſtance from the other: And let it be alwayes exactly of the diſtance of ſix hours after the French way: Firſt of all, this ſtring deſcribes the Equinoctial line in the ſuperficies of the Dyall, Secondly when one of the two, either the half circle or the ſtraight line O q, is found in one of the points of the hours of the Equator, th'other is likewiſe found in it, in an other point of hour, then drawing with a ſtring coming from the center O, a ſtraight line that may go from the point, as t, to the end of the ſtraight line O q which you ſhall go drawing with this ſtring made ſhorter or longer, as need requires, and mark ſome points of line of hour, after the Italian or Babylonian way in the ſuperficies of the Dyall.

And for this purpoſe there is nothing ſo eaſie as to have a circle of Equator, that may be fitted to the half circle, and where you may have alwayes a ſpace ready made for it's hour.

Fig.

4


B
N
O
L
Q
VI
1
V
IIII
III
II
I
XII
XI
P
R

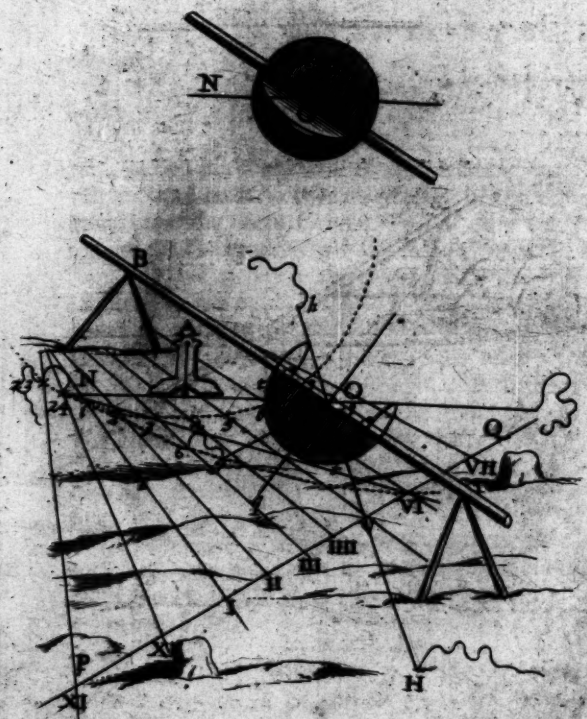

N
B
A
N
Q
Q
VII
VI
IIII
III
II
I
P
XII
XI
H

Figure 25.

To mark the hours after the manner of the Ancients or the Jewes.

YOu must know first that it would be very troublesome to draw in the superficies of the Dyall, the lines of this kind of hours in such a manner as that they might be alwayes just and right in theory, all the year long.

And therefore it is sufficient to draw them just by demonstration in three points onely, *viz.* in their points of both ends, and of the middle, which are the points of those circles that appear the greatest above the Horizon being parallel to the Equator, and of the Equator it self.

The rest goes as it may, and therefore it may be said, that the lines of such hours traced in this manner are false in the rest of their length, yet Curiositie makes them passe for current.

Wherefore to mark this kind of lines of hours.

The higher figure 4 shewes which way you must make this half Circle to turn about, *viz.* about a straight axel-tree line placed levell in the center of the Axel-tree of the Dyall.

And to be short, set up and make very fast a rod in a straight line passing to the center O, and let it be first within the joynt of the axeltree rod, secondly let it be level, as the figures do shew of a plummet P. and of a level A, this being done, tye some strings with a loose knot to this rod so levelled N L as you see N R, and L T.

Take the string from about the center O, stretch it out in a direct or straight line from the center O to one of the points

points of hour, after the French way, of the Equinoctial line of the Dyall, for example to the point of 1 hour, as you see the string OI.

This string being thus strecht out, take the other strings of one or th'other end NL, and Crosse over this string OI with them, and so go and mark many points in the superficies of the Dyall, as TIR.

Draw an obscure line by those points as TIR, it is a line of hours after the manner of the Ancients or the Jews, do the like with the other hours and half hours of the Equinoctial line.

If you leave a rod in the Dyall, as N O L, the shadow thereof will go and shew these hours continually at length, if you will not leave it in, the button or center O of the axeltree of the Dyall will shew them.

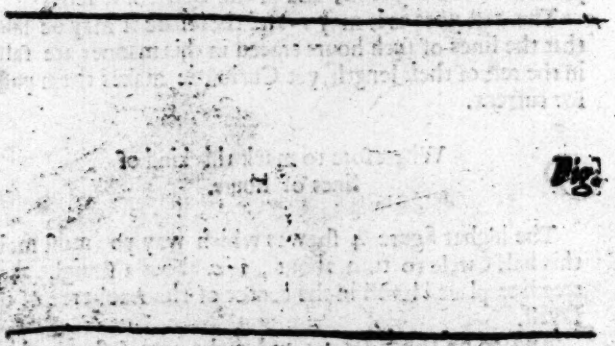
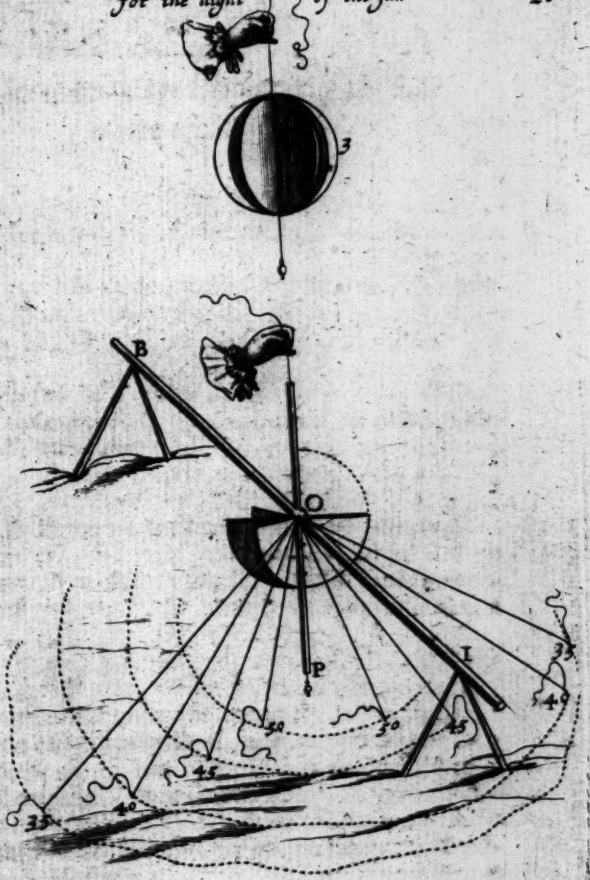


Fig.


3
B
O
P
I
35
40
30
45
45
40
35

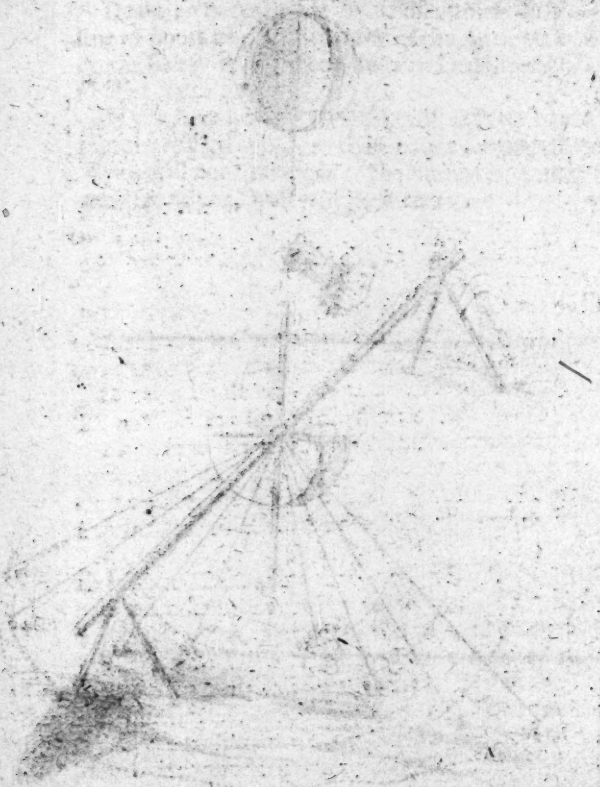


Figure 26.

How to mark the Elevation of the Sun above the Horizon.

THE higher fig. 3. ſhews which way you muſt turn the half circle, *viz.* about a ſtraight axel-line hanging down right.

Set up your half circle, ſo that it may turn like a weather-cock about a rod hanging down right, or plum, above or below the axeltree of the Dyal, it matters not which.

VVhileſt you turn it thus as it is above ſaid, cauſe in the mean time the ſtring comming from the center O to paſſe by one of the degrees of the edge of the circle; and make the ſtring ſhorter or longer as need ſhall require; mark with it many ſeveral points in the ſuperficies of the Dyal; according as you ſee them rankt one by an other, in four places.

Draw a ſmall or obſcure line through all theſe points, and this will be one of the lines of the Elevation of the Sun.

Count the Degrees in the edge of the circle, beginning at the firſt of the beam which is level, and ending at the 90. Beam which is down right or plum.

Mark in the line of the Dyal, the nnmber of the Degrees of the border of the circle, where the ſtring paſſes that hath mark't the points of that line, and ſo of all the others, and the ſhadow of the button of the axeltree which is in the center of the circle, will ſhew the Elevation of the Sun above the Horizon.

Figure 27:

How to mark the Sun rising, or East rising of the Sun.

THE figure 2 above shews how you must place the half circle, *viz.* parallel unto the Horizon, I would not put a levell to it to avoid confusion. It shews also that one of the Diameters of the circle must be set within the center of the Dyal, that is to say, that it must go directly from the south to the North, and accordingly the Diameter which is perpendicular to it, will go from East to West.

When your circle is set fast in this position, let a plummet o p in the lower figure hang from the center O.

This being done, from each point of Degree of the edge of the circle, as from x and from z. mark with a string XT or ZR. many points in the superficies of the Dyal.

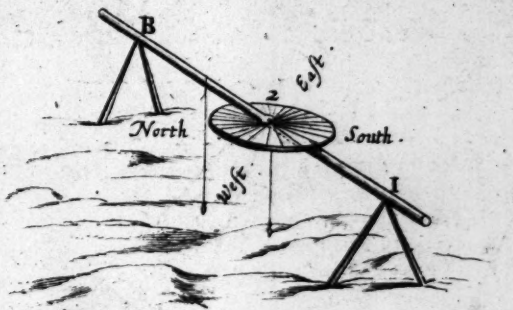
Draw a small or obscure line through these points, as TY or SR. it is a line of the Suns East rising.

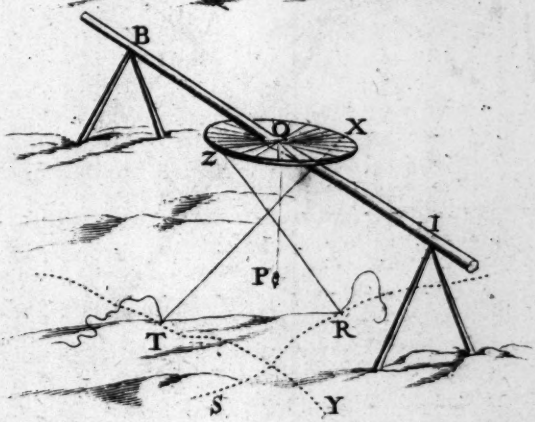
Mark in it the number of Degrees of the point of the circle from whence the string comes, according as you will count them, to begin either from the East, or from the South. And so of all the other Degrees accordingly.

And the shadow of the button O will shew which way the sight of the Sun comes upon the Dyal.

I will take here occasion to tell you, that if for some reason or other, you could observe, in one and the same day, but two shadows of the Sun in stead of three, as we have said in the placing of the axeltree in the Dyal, the declining of the Sun in that day, will serve you for a third shadow, or else two other shadows observed in an other day. I mean you may find equally the placing of the axeltree by one or other of those ways above mentioned, and with 3 shadows; and with 2 shadows, and the declining of the Sun in that day, and with 4 shadows, two of one day, and two of an other, which are three wayes that come all to one.

Fig.


B
East
2
North
South.
West
I


B
O
X
Z
I
P
T
R
S
Y

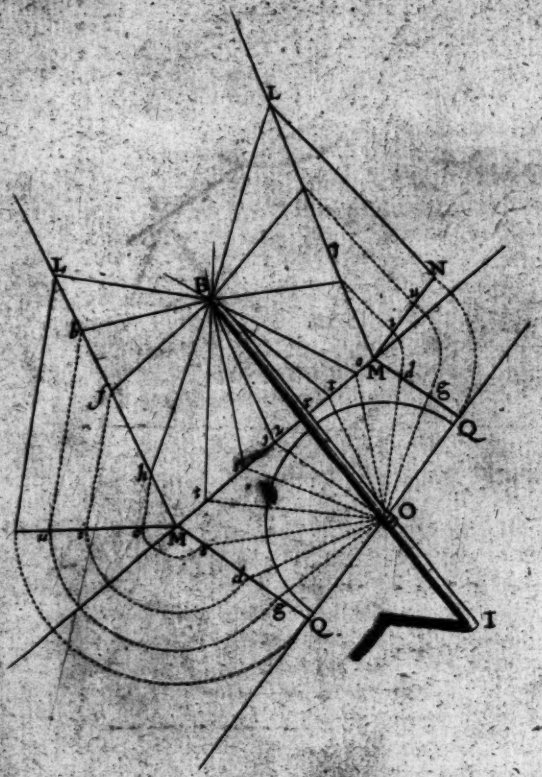

L
L
B
N
M
Q
O
M
Q
I

Figure 28.

I do not specifie in this volum these kinds of flat Dyals, wherein you may work without knobs or middle rule: And where you may draw the Equinoctial line: trace out and divide the circle Equator: in a word, where you may do all: yea and in the very superficies of the Dyal, you may easily come to know them you self, by putting this universall way into practice.

Here is onely a way how to trace out all the twelue lines of the hours equal, after the French way, in the flat Dyals where the axeltree meets the superficies athwart in the space that you work in, so that you shall have no need of a greater place. And what I have already said, and what I am now going to say again, will serve to find out the way to do the like in all kinds of Dyals universally.

When you have drawn upon your Dyal the Equinoctial line M 12 M, drawn conveniently and divided the circle Equator Q 12 Q bring to the Equinoctial line, the beam of the 12 hours Q, 12. Draw of both sides of the Equator, and from the Equinoctial line a straight line M Q parallel to the beam of 12. hours O 12. bring the beams of the other hours to the first, which they shall find of the Equinoctial in r t: and of M Q in c, d, g, Q. Bring in the Dyal the line of the twelve hours B. 12. draw by the point M, of the Equinoctial line, and from the center of the Dyal B a straight line M L parallel to the line of twelve hours B 12; make upon this line M L and upon the point M a triangle L M N like to the triangle in the aire O B 12. and let the angles of these triangles in the points L and B be equal one unto an other. Carry the spaces M q, M g, M d, M c, from the straight line M Q into the straight line M N, *viz.* from M into N, into u, into i, into o, bring by the points

N, u, l, o, some straight lines N, u, l, o, h, parallel to the side, N L of the triangle, LMN: Carry from the center of the Dyal B by the points r, t, h, f, o, L, Some straight lines, BL, Bh, Bf, Bh, Bt, Br; These are such lines of hours as you may continue beyond the center B, and mark them according to their orders.

THE END.